THE Petroleum Engineer

ALL DIVISIONS
- Exploration Drilling and Production
- Refining and Gas Processing
- Oil and Gas Pipelining

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Dangerous "Forces of Propaganda"

The oil industry is the object of a determined propaganda attack from self-labelled "liberal" forces sparked by sensational journalists and propelled by politicians who have neither time nor inclination to understand the complicated workings of the industry. Walter S. Hallanan, Plymouth Oil Company president, presents in this issue many instances of the inaccuracies of the propaganda group on questions that affect the oil industry. (A-33.)

Milburn Petty, our Washington correspondent, was one of the first to realize that a strong group in Washington forms instantly to fight the oil industry on legislation. The strength of the clique was revealed in the record flood of letters President Truman received asking him to veto the Kerr gas bill. In this particular case indifference to fact were so outrageous as to be humorous had they not been so wonderfully effective. Franklin D. Roosevelt, Jr., went on the radio and told people to write the President to veto the bill if they didn't want to pay higher gas rates. Drew Pearson conducted a campaign worthy of a hired press agent. Here's a sample paragraph: "Usually fair-minded Speaker Sam Rayburn revived memories of whip-cracking Uncle Joe Cannon by his haste to get House approval of the *Kerr bill boosting national gas prices.*" (Italics ours). Actually the Kerr bill was aimed at allowing costs to follow the law of supply and demand, which make a raise or fall in prices equally possible.

The public received little information in favor of the bill and what it did learn apparently made slight impression. For one reason an appraisal understandable to the layman of the probable effects of any bill concerning the oil industry is not an easy task. It is becoming increasingly difficult and at the same time increasingly important to explain the vast operations of our large U. S. industries. Another reason for ineffectual pro-oil publicity is that all too often the industry itself is not agreed and, to some extent, are even afraid of agreement, which might attract the zealous Department of Justice. A third difficulty in presenting the oil industry's side on a question is that there is no regular channel through which information can be given the public except straight news publicity that would certainly land in the waste basket if it held the crusading fervor of the Pearson-type journalist. Another important point is that oil states are overwhelmingly Democratic, greatly lessening their political influence with both parties.

Despite these obstacles, and because of them, greater efforts must be made to get a calmer and more comprehensive view of the industry before the public. If the industry does not get its story across it is going to be radically changed by expanding controls. Former Oklahoma Congressman Wesley E. Disney last month warned the AGA meeting that threat of a federal fuel-administrating body came from these anti-oil industry "propaganda forces." So far these forces have shown considerably more power than the petroleum industry has been able to assemble.

It is not enough to be alerted against further controls. It is time to push forward the provable fact that the industry serves the public well—not only efficiently but responsibly and conscientiously.—E. A.

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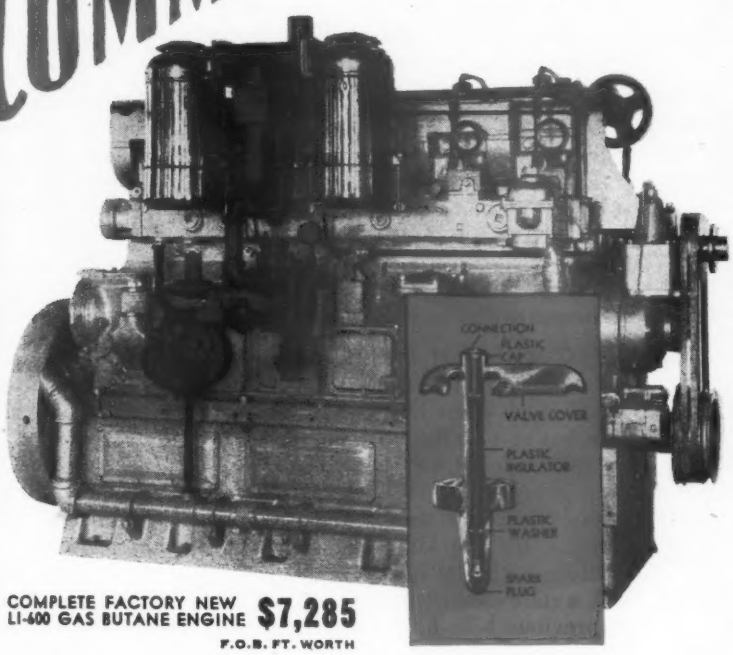

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Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—President Truman has moved in on the oil import situation, convinced that something should be done to prevent "ruin" of the coal industry and the independent oil man—but he is still not certain just what to do.

None of the interested parties—government, industry and congressional leaders—really wants legislation to control imports, if there is any other way out. So, the best bet is still that the chosen instrument will be a voluntary cutback agreement among the importers.

The import problem has been discussed at several recent meetings of the Cabinet as the coal-state senators and congressmen increase the pressure for action on imports, particularly against foreign residual fuel oil which they blame for their lost markets.

Told at one of these meetings that final figures might show April imports above 900,000 bbl a day, President Truman expressed his concern and instructed Interior Secretary Chapman to look into the matter further and come back with suggestions.

▸ **Import Conference.** Secretary Chapman is considering the calling of a conference of all the parties—importers, producers, refiners, oil unions, coal operators, and mine workers. Face to face, each group would state its arguments and then cross-examine the other side on its statements. It could develop into a lively session.

▸ **Voluntary Agreements.** At such a meeting, Chapman might suggest to the importers that they join in a voluntary cutback that would be "blessed" by the attorney general. If they were unwilling (because there is no statutory basis for such anti-trust law clearance), Chapman might counter with a proposed "quickie" law to authorize specifically such agreement. However, a "persuader" might be included in the law, namely, a provision authorizing the Secretary of Interior to impose import quotas if the companies still shied away from joint action to cut back.

▸ **OGD Is Opposed.** Director Stewart of the Oil and Gas Division has advised Chapman against any action to limit imports, contending that the industry does not yet realize the huge demand in prospect for this summer and fall. Instead, Stewart urged that Chapman suggest to the state oil authorities that production allowables be increased to build up stocks against the possibility of shortages.

▸ **Coal Joins Fight.** Despite the criticism by some oil leaders, such as Paul Blazer (Ashland Oil and Refining Company), of a "political alliance" with the coal interests against oil imports, there is no denying that the coal lobby's activities have been effective. Every now and then, though, one of the coal-state members takes a potshot at other matters than imports—the oil-gas depletion allowance, for example.

▸ **Depletion.** Senator Kilgore (D, West Virginia), who describes himself as an ex-wildcatter, digressed from his attack on imported fuel oil to say he had always favored the 27½ per cent depletion allowance . . . but only for the encouragement of domestic oil development. It was never intended, Kilgore added, that this tax privilege be used to build a "slush fund" for financing the development of foreign oil reserves to compete with the domestic industry.

Meanwhile, it now appears that, if there is a tax bill coming out of the Ways and Means Committee, it will not change the 27½ per cent depletion allowance. But there may be an attempt to amend the bill on the floor to include the Treasury's rollback provisions. If so, the debate will be rough, the final vote very close.

The issue is not likely to die with this Congress, however, because President Truman has just appointed a long-time foe of the oil-gas depletion allowance to the three-man Council of Economic Advisers, who sit at Truman's elbow on economic matters. He is Roy Blough, who spearheaded Treasury's 1942 drive against this oil tax provision.

▸ **FTC Probe.** Whether the 27½ per cent depletion allowance is "excessive" would be one of the matters investigated by the Federal Trade Commission, if Congress votes it the $250,000 proposed by Congressman Cannon (D, Missouri) for a comprehensive study of the industry as a basis for Congress to develop a national oil policy. Cannon has hinted that, if such authority isn't given, then his appropriations committee might vote the needed funds for such an investigation under the FTC's general grant of authority.

▸ **FTC Miffed at DJ.** The FTC, which has been trying to horn in on oil investigations and file a case or two itself, was miffed when the Department of Justice filed a new omnibus suit on the Pacific Coast. For over a year, the FTC has had hopes of working up an "oil conspiracy" case which "would rival the API-Mother Hubbard Case." Now, FTC officials feel that the DJ has taken away some of their thunder. By attacking the "private proration program" in California, the DJ has made it certain that the industry will seek a state conservation law. Most of the leading opponents of previous bills have now come around to favoring such a law.

▸ **DJ Sets Pattern.** DJ officials say that other antitrust oil cases "are in the works," which would accomplish the same objectives sought in the Pacific Coast suit. So the new suit can be regarded as the pattern for what the DJ hopes to bring about in the oil industry. Among these aims, as indicated in the Pacific Coast complaint, are (1) marketing divorcement, (2) opening up exchanges to any oil company, (3) making transportation and storage facilities available to any company, (4) stop throughput deals between majors and independent refiners, and (5) ban the posting of prices for crude and products, which the DJ regards as a "market leader" system used to maintain prices.

▸ **Gas.** New England congressmen are up in arms about "delaying tactics" of the Federal Power Commission in handling pipeline applications to bring natural gas into their area "which is the only remaining industrial area without this cheap fuel." They blame the coal and railroad interests for "blocking" approval. But the FPC's only reaction to pressure from the New Englanders was to announce the scheduling of another hearing "soon" at Boston for more testimony about the pipeline projects.

▸ **OGD's Fate.** Now that the Interior Department's reorganization program has been approved by Congress, including the provision for a new assistant secretary, it can be expected that there will be a reshuffling of the department's oil and gas activities. One move may be to transfer the Oil and Gas Division's functions under the Connally "Hot" Oil Law to the Geological Survey. Later, there may be other reductions in OGD's functions as the trend grows to merge and concentrate all petroleum activities under one head.

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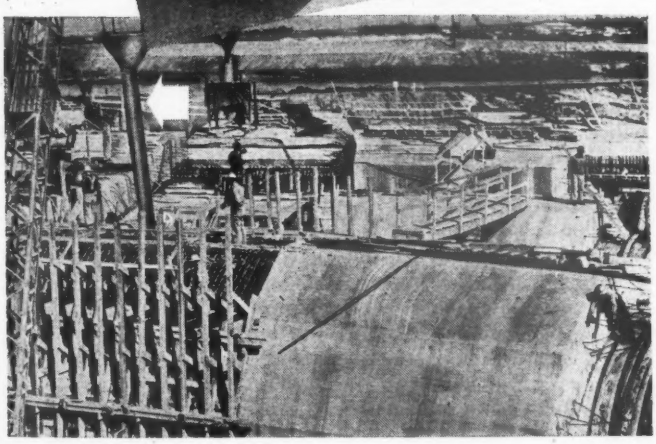

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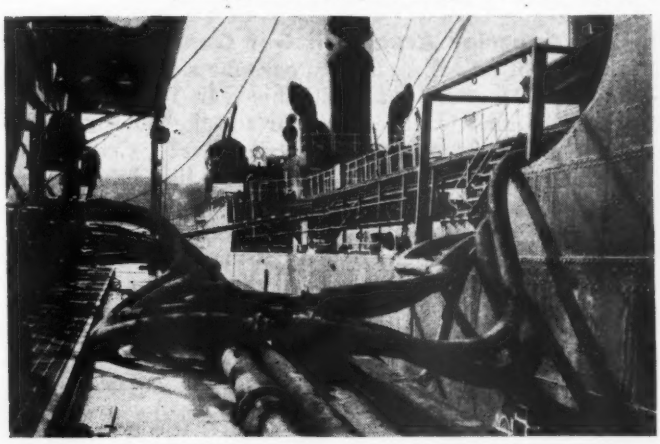

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Highlights in Oildom

Federal Control on Fuels Threaten: Disney. The natural gas industry had better keep a sharp lookout for efforts in Washington to increase federal control on all fuels, warns Wesley E. Disney, new counsel for the Independent Natural Gas Association. Speaking before the opening meeting of NGA's natural gas department in Tulsa, Oklahoma, Disney warned that should a fuel-administrating body be set up, it would regulate all fuels "and naturally would include price fixing." The threat of regulation comes from the "forces of propaganda," which defeated the Kerr gas bill, Disney declared.

ECA Grants Funds for French Plants. The Economic Administration has allocated $230,000 to buy equipment for two French oil refineries, bringing total disbursements to $1,480,000 since last August. At that time it authorized $11,000,000 to alterations and additions to the Gonfreville and La Mede refineries. ECA's share is $3,150,000 and the balance will be financed in other currencies. The improvement will enable France to turn out better quality lubricating oils and higher octane gasoline, ECA stated.

Oil Industry Thriving, Compact Told. According to Oklahoma's Governor Roy Turner, the oil industry "is in one of the healthiest conditions that it has enjoyed for years." Turner, speaking before the spring meeting of the Oil Compact Commission, reported that the status of the industry could be credited to regulating bodies of the oil producing states. Action by the regulating bodies has not been without injury to the states, Turner continued, but allowables had been cut without disaster to the industry. He pointed out that the economics of most large oil and gas companies have been built around their production.

Lake Superior Area Will Get Canadian Oil. The first barrel of oil will be let into one end of a pipe line near Edmonton, Alberta, Canada late this year. The oil will then travel 1180 miles to Lake Superior and the Interprovincial Pipe Line will have made its first delivery. Crude from Alberta wells will go through the pipe line into 10 steel tanks holding 150,000 bbl each.

The line will enter the U. S. at Neche, North Dakota, just across from Gretna. Capacity of the line will be 95,000 bbl to Regina, with 70,000 bbl of that amount continuing eastward.

Propose State Oil Supervision. The South Carolina Senate has passed a resolution to study the advisability of placing the oil industry under the supervision of the state Public Service Commission. The resolution also calls for an investigation of wholesale and retail petroleum prices in South Carolina.

The House has already passed a measure that would immediately vest the Public Service Commission with power to fix maximum and minimum prices for petroleum products. The latter bill is now being considered by the Senate judiciary committee.

Request Oil Import Duty. Representatives of the coal, railroad, and domestic oil industries are requesting an amendment to the tax bill now pending before the House Ways and Means Committee restricting oil imports.

Together with certain labor groups these industries contend that they are being seriously damaged by "excessive" oil imports to the U.S. They propose cutting down the flow of oil to the U. S., and tax imports of crude oil and gasoline.

Suggests Equalizing Lube Tax. The time is ripe for Congress to give favorable consideration to equalizing lubricating oil taxes by imposing a six-cent a gallon levy on reclaimed oil, directors of the Pennsylvania Grade Crude Oil Association were told, by D. C. O'Hara of the association legal department.

Reclaimed, or re-refined oil as it sometimes is called, currently is exempt from taxation because the reclaimer is not ready to declare his product as equivalent to a new oil. Reclaimed oils frequently are offered in competition with virgin lubricating oils on which a tax of six cents a gallon is levied, oil men point out. O'Hara urged that oil men make known their views to members of the House Ways and Means Committee, as a new tax bill is being readied and fresh sources of revenue are being sought.

Mexico Oil Demand High. Petroleos Mexicanos, the Mexican government controlled oil company, has reported that Mexico's requirements have grown at 2½ times the rate of those in the U. S. in the last 12 years. Mexican domestic consumption, rose to 44.6 million bbl in 1949, and an increase of 205 per cent over 1937. U. S. demand, reaching 2.1 billion bbl in 1949, represented an increase of 80 per cent for the same period. This greater rate of increase reflects the rapid industrial and agricultural growth taking place in Mexico, stated Senator Antoino J. Bermudez, director general of Pemex.

Increase Drilling in Germany, Engineer Reports. Germany may soon be the scene of a large oil drilling program, and several new fields may be found in the next few years, is the opinion of Friedrich Brueggemann, chief engineer of Wintershall, A. G., Germany's largest oil company.

Touring American oil fields to observe drilling and producing methods, Brueggemann stated that the company keeps 22 drilling rigs operating, and estimates that it drills about 75 wells a year. Although he does not think Germany will ever become self-sufficient in oil, it does produce about one-third of the oil she needs under a proration set up.

Utilization Balances Consumption: Holaday. Crude petroleum consumption is at a record level in this country but, due to results of the petroleum industry's research efforts, so is utilization of each barrel of crude, according to W. M. Holaday, Socony-Vacuum Oil Company, Incorporated, New York. Speaking before the American Institute of Chemists, he pointed out that a saving of 1,000,000 bbl per day of gasoline—or 2,000,000 bbl per day of petroleum—is being made currently in comparison with 1930 efficiencies of utilization. A barrel is equivalent to 42 gal.

Gasoline from Oil Shale. The producing of motor fuel from coal or oil shale can never compete in price with petroleum-based gasoline is the opinion of Dr. Robert E. Wilson, board chairman of Standard Oil Company (Indiana). He challenged rumors implying the oil industry seeks to obstruct development of synthetic fuels, and declared if a method is ever discovered for producing gasoline equivalent in quality and cost to gasoline from crude oil, his company would put it into use.

Speaking at a press conference preceding presentation of the American Petroleum Institute's certificate of appreciation, Wilson added that as "long as oil is running out of the ground as freely as it is now, processes involving coal and shale will have to undergo considerable improvement before they can compete."

In 1940 there was . . . *1*.

In 1944 there were . . . *215*

In 1948 there were . . . *500*

and as of May 1950 there are more than

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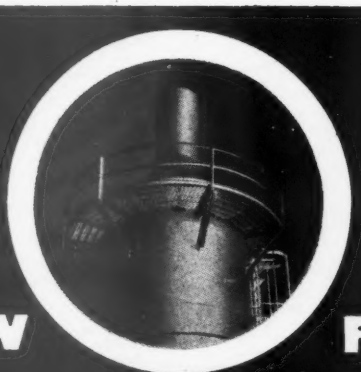

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National Petroleum Situation

Rising Gasoline Demand. Consumption of gasoline in April rose sharply to a daily average of 2,836,000 bbl, which represented an increase of 7 per cent above a year ago. Demand in the first 4 months of this year was 5 per cent greater than last year. The upturn in demand was accompanied by a reduction in stocks of more than 7,000,000 bbl, and marked the seasonal downward trend in previously accumulated inventories. The April demand is indicative of the record-breaking requirements of the motoring public in 1950, and it is quite likely that the domestic demand will exceed the most optimistic forecasts made for this year.

Stocks Sharply Reduced. The heavy demand for fuel oils this year, coupled with a substantial increase in motor fuel consumption, brought sharp reductions in stocks and brought the combined inventory of all oils down to a level which is 14 per cent below a year ago. Stocks of all oils have been reduced this year to the extent of about 70,771,000 bbl, whereas in the same period of last year there was an accumulation in stock of 14,936,000 bbl. Stocks of fuel oils are now about 33 per cent less than a year ago, while motor fuel stocks are slightly greater than last year, but may be expected to drop materially during the next four months. Crude oil stocks are 11 per cent below a year ago.

Producers' Outlook Favorable. The prospect of substantially greater requirements for crude and products this year is highly favorable to oil producers. The trend of demand this year is expected to result in a material increase in refining operations, which is likely to lift domestic crude production in the third quarter of this year to a daily average of about 5,500,000 bbl. This would be about 500,000 bbl greater than the April rate. Demand in the first 4 months of this year was nearly 600,000 bbl greater than supply. The supply of all oils was 6,203,000 bbl daily, while demand was about 6,800,000 bbl daily. This is highly favorable to continued stability in crude oil and product prices, and markets are likely to remain strong throughout this year.

Drilling Continues Brisk. Stability in the crude market continues to promote a high rate of drilling operations. There are more active rigs now than ever before and well completions are about 8 per cent above last year. Wildcat operations are 13 per cent above last year, and are likely to move higher as demand calls for more crude production.

Comparative Statistics, April, 1950

*All figures are computed on a Bureau of Mines' Basis**

	April 1950 (P)	March 1950 (P)	April 1949	This Year to date (P)	Last Year to date	Per cent change
Total supply,* all oils	186,410	192,226	180,484	744,417	750,031	— 1
Daily average	6,214	6,200	6,016	6,203	6,250	
Total demand†, all oils	198,958	222,303	174,649	815,188	735,095	+11
Daily average	6,632	7,171	5,822	6,800	6,126	
Change in stocks	—12,548	—30,077	+5,835	—70,771	+14,936	
Crude supply*	162,620	164,674	162,306	645,560	679,175	— 5
Daily average	5,421	5,312	5,410	5,380	5,660	
Crude demand†	160,770	167,574	159,127	656,214	663,282	— 1
Daily average	5,359	5,406	5,304	5,469	5,527	
Crude stocks	242,700	240,850	272,520	242,700	272,520	—11
Days supply	45	44	51	45	51	
Natural gasoline production	14,570	15,200	12,335	58,625	50,164	+17
Daily average	486	490	411	488	418	
Motor fuel production	76,900	81,680	77,157	314,377	308,318	+ 2
Daily average	2,563	2,635	2,572	2,620	2,569	
Gasoline yield per cent	42.1	42.0	44.1	42.1	42.3	— 0.2
Motor fuel demand†	85,100	80,462	79,111	299,294	285,105	+ 5
Daily average	2,836	2,595	2,637	2,500	2,376	
Motor fuel stocks	126,450	133,650	124,273	126,450	124,273	+ 2
Days supply	44	51	46	44	46	
Fuel oil production	62,600	66,500	59,785	260,627	266,729	— 2
Daily average	2,086	2,145	1,993	2,172	2,223	
Fuel oil demand†	75,120	99,799	62,270	360,916	313,313	+15
Daily average	2,504	3,219	2,076	3,007	2,611	
Fuel oil stocks	74,900	79,050	110,899	74,900	110,899	—33
Days supply	25	24	53	25	53	
Refinery still runs	156,210	166,570	154,223	641,604	648,877	— 1
Daily average	5,207	5,373	5,141	5,346	5,407	
Stocks, all oil	532,350	544,898	620,679	532,350	620,679	—14
Days supply	80	76	107	80	107	

Current Crude Oil Prices

U. S. Average	$2.56	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.62	Mississippi	2.23
Kansas	2.62	Illinois	2.76
		Other states	2.60

Basic crude prices:	
Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.80
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (26 gr.)	2.31
Pennsylvania, Bradford	3.65

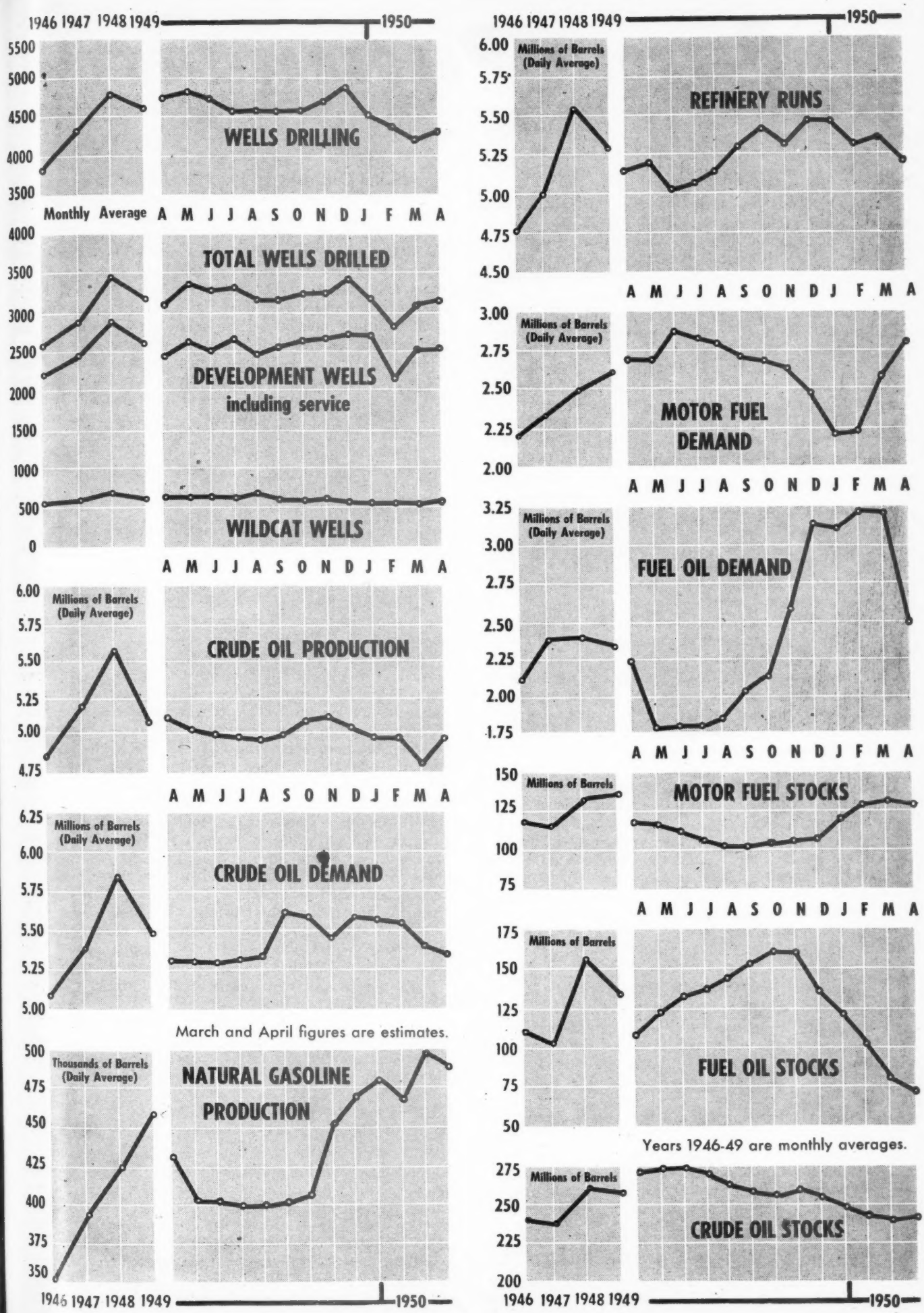
Drilling and Production Statistics

	April 1950 (P)	March 1950 (P)	April 1949	This Year to date (P)	Last Year to date	Per cent change
Wells Drilling	4,390	4,270	4,520	4,390	4,520	— 3
Total wells drilled	3,209	3,181	3,147	12,467	11,754	+ 6
Development wells	2,550	2,531	2,460	9,921	9,289	+ 7
Oil	1,826	1,741	1,683	6,922	6,391	+ 8
Gas	168	190	224	728	833	—13
Dry	556	600	553	2,271	2,065	+10
Per cent dry	21.8	23.8	22.5	22.9	22.3	+ 0.6
Service wells	60	62	125	279	465	—40
Wildcat wells	599	588	562	2,267	2,000	+13
Oil	86	85	102	336	338	0
Gas	11	17	13	68	51	+34
Dry	502	486	447	1,863	1,611	+15
Per cent dry	83.8	82.7	79.4	82.1	80.5	+ 1.6

By State

Wells drilled (excl service)	3,149	3,119	3,022	12,188	11,289	+ 8
Arkansas	34	24	37	121	92	+25
California	134	122	221	546	843	—35
Illinois	157	156	148	663	631	+ 5
Kansas	287	293	274	1,091	932	+17
Louisiana	194	177	143	771	666	+16
Mississippi	36	24	33	109	113	— 4
New Mexico	49	52	40	220	164	+34
Oklahoma	458	428	426	1,608	1,225	+31
Texas	1,330	1,359	1,049	5,109	4,257	+20
Other states	470	484	651	1,950	2,366	—18
Wildcats drilled	599	588	562	2,267	2,000	+13
Arkansas	7	3	6	31	17	+82
California	27	34	34	118	165	—29
Illinois	50	38	27	178	100	+78
Kansas	50	49	29	189	143	+32
Louisiana	25	15	33	92	95	— 3
Mississippi	19	12	3	47	30	+57
New Mexico	4	6	4	26	28	— 7
Oklahoma	63	74	70	269	221	+22
Texas	265	287	270	1,016	837	+22
Other states	89	70	86	301	264	+19
Daily crude production	4,984	4,830	5,012	4,924	5,249	— 6
Arkansas	88	92	86	89	86	+ 3
California	860	862	942	864	945	— 8
Illinois	179	180	175	174	173	0
Kansas	272	264	291	271	291	— 7
Louisiana	537	527	520	547	519	+ 5
Mississippi	95	103	109	98	110	—11
New Mexico	127	131	131	130	133	— 2
Oklahoma	441	423	421	423	425	0
Texas	2,043	1,900	1,958	1,966	2,194	—10
Wyoming	162	162	127	158	125	+26
Other states	180	186	252	204	248	—18

*Unless otherwise stated all figures represent thousands of barrels. (P)–Preliminary. *Includes domestic production and imports.
†Total demand, including exports.
Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.


1946 1947 1948 1949
1950
WELLS DRILLING
Monthly Average
A M J J A S O N D J F M A
TOTAL WELLS DRILLED
DEVELOPMENT WELLS
including service
WILDCAT WELLS
CRUDE OIL PRODUCTION
Millions of Barrels
(Daily Average)
CRUDE OIL DEMAND
March and April figures are estimates.
Thousands of Barrels
(Daily Average)
NATURAL GASOLINE
PRODUCTION
REFINERY RUNS
MOTOR FUEL
DEMAND
FUEL OIL DEMAND
MOTOR FUEL STOCKS
Millions of Barrels
FUEL OIL STOCKS
Years 1946-49 are monthly averages.
CRUDE OIL STOCKS

PETROLIC PERSONALITIES

DICK SNEDDON

Git Along, Little Doggie

From away out yonder in the wilds of Arizona comes another story of the range that has the cayuse and lasso mob ringing its spurs in sheer exasperation. Hit seems the way we hear tell that a bunch of the boys was a whoppin her up one night on a dude ranch in the vicinity of Tucson, when out of the night that waren't fifty below nor nuthin like it, staggered a stranger — clean as a houn's tooth an hansom as all git out. He shore had the marks of a city feller, an the synthetic cowpokes commenst a nudgin each other an a snickerin behint thair hans. But the newcomer diden pay no attenshon. He jest stood thar a slappin the san outa his cloes with his mittens, an transfixin the titterin cowboys— an cowgirls too — with his piercin eyes — till they was as silent as a herd of girafts. Then, careless like, he rolled a coughin nail with his left han, lighted it with a dimon studded ronson, blowed a super silyous smoke ring or two at the cowed assembly, and stalked off tuh his boodwar.

Little did the gang think then that the hansom stranger was none other than ole Stringalong Texter, knowed among the boys over tuh the Youngstown Rancho in Chicago by the name of Wild Bill Texter, as hard ridin a hossman as they is in the Windy metrollops. But twaren't long till they foun out. Necks mornin Stringalong lept outen his hay box, roped a frisky mustang, and afore the sun had harly clime above the hoe rizon, was off at a brisk galup over arroyos, barrancas, an other groun formashons with even funnier names. Enyways, wen Chicago's answer tuh the Bufflo Bill legend loped back tuh the hacienda later in the mornin, the lads and lassies was all set tuh mebbe give him a genris helpin of razzberrys. But effen that was thair original idee, they shore change thair mines quite sum wen they seen how ole Stringalong could sit his saddle.

Hit seems like Bill Texter is a retire calvary offiser, an knows more about hosses than a holesale hamberger house. Wen the dudes an gals foun out that he could make a wall eyed pinto with burrs onder his saddle act as gentle as broiled spring lamb, they clutert roun him like he had jest win the Dublin sweet steaks, an from then on, he was the most popular cowpoke in Arizona. Lass word we herd from our Lake Michigan representative was that Bill had the bess time of his rugged career at the dude ranch, an is now back at his Chicago desk feelin fitter than a Green Bay tackle.

A Noble Among Notables

Who should we meet not long ago, doing the Los Angeles rounds with Paul Huggins, Tom Wallace, and Jerry Bowen, but that restless soul and leading citizen of Pittsburg Pennsylvania, Gordon Gulley. Gordon hails originally from the Hoosier state with such notables as George Ade, Ring Lardner, and Booth Tarkington; grew up in Arkansas with such notables as Bob Burns, Lum Peters, and Abner Peabody; worked in Oklahoma with such notables as the Oklahoma Aggies and Hal Price; and finally made his way to Pennsylvania with such notables as Fred Waring and his half a hundred, the Saturday Evening Post, and Andrew Carnegie. He was born in Clayton, Indiana, graduated from William Jewell College, Liberty, Missouri, and first became an oil man in 1917 with the Osage and Oklahoma Gas Company, from which he migrated to the USGS. He also spent six years with Marland Oil Company about this time and, indeed, helped Carl Beal organize Marland from the old Coast Land Company. In 1928, he attached himself firmly to Gulf Oil Corporation as a geologist and nobody has been able to wrench him away ever since.

After about 20 years of geological polysyllabics he graduated into personnel work, and at present he is personnel relations adviser to the production and pipeline department, and loves it. His headquarters are in Pittsburgh but he dashes hither and yon by plane, passenger train, and pogo stick, visiting such interesting territorial segments of the continent as the Gulf Coast, Northern Quebec, Alaska, and Venezuela. When out on these jaunts, he never fails to look around for another trout stream. He is by preference a dry fly fisherman, which reminds us — isn't it amazing that even flies become dry? His other hobby is hiking, an ancient but rather ingenious species of ambulation that is contrived by alternately placing one foot in front of the other. It used to be quite common but is now almost a lost art.

Anthropology Notes

A brief note comes by carrier pigeon from By Landis and Cammie, the nomadic Web Wilson people, now on their regular spring pilgrimage into those little known regions lying east of the Rockies. At the moment of writing they have just discovered a lovely village in Oklahoma with the quaint name of "Tulsa," which means in Cherokee, "heap big oil town and plenty wampum." The Landises report that the natives are friendly, well educated, and live in beautiful homes, but have one very peculiar custom. They seem to perform all trench digging and other excavation work during the weekends with eight irons. Anyway, the explorers are determined to return to this interesting bailiwick at another time and do some more reconnoitering.

At the moment, it appears that they are wending their devious way towards a considerable encampment on the East Coast, known as New York. This strange place, according to previous adventurers, is peopled by great throngs of hurrying men and women who spend the better part of their lives getting on and off subway trains, or trying to get tickets for South Pacific. Our travelers have this South Pacific deal licked, we understand, and one of these evenings when Mary Martin looks down at the front row she will find, sitting there as large as life, By and Cammie, and if she feels as good as the rest of us do when we see By and Cammie, she will probably give the best performance of her career. Incidentally, with his note, By encloses his latest calling card, which takes the form of a celophane package of Tiger prunes, bearing his own moniker as prune picker for the Web Wilson interests. Prune picker is a term of endearment applied to California oil men by oil men from other states.

That Warn't No Smog—Just Smoke

It is whispered in the supreme councils of the petrochemical patriarchs, acording to Agent X, our petrochemical keyhole peeper, that Ray Miller, the E. I. duPont des Nemours wheel has taken his way west with the biggest consignment of Optimo Kings ever transported interstatewide by a single cigar carrier and consumer. As a matter of fact, the dense cloud of blue smoke that has blotted out everything between Wilmington, Delaware, and Los Angeles, California, is being studied by smog committees, chemists, and bacteriologists all along the route, and there is a very

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decided possibility that the pall may yet be used for the manufacture of an unusually thick species of carbon black, if it is not grabbed by the department of agriculture to be employed as a fungicide.

Ray, in case you haven't heard, is director of sales for the duPont petroleum chemicals division; a World War I aviator; a past secretary of NGAA; and at the time he joined up with duPont was vice prexy for the Warren Petroleum Company of Tulsa, Oklahoma. He plays a pretty sharp game of golf; trains on boneless shad; and likes nothing better than to participate in the annual telegraphic divot-lofting contest between NGAA and CNGA, which usually takes place in June.

This year he will be scarring the good earth at Rio Hondo Club out in California and well be renewing acquaintances with a scad of old friends who always look forward to his coming. Last winter Ray fell on the ice right at his own front door and broke his arm. It interfered briefly with his reach but we understand he is again able to snag the mustard from the other end of the table without any help from the sides. In conclusion, we might state that although a grandpop and proud of it, he still has more energy than a disintegrating uranium atom.

Imported Personality

Down from Vancouver, Canada, a short time ago came a right personable individual named P. J. Sharp, who quickly became Pete to a raft of local oil biggies. They hadn't known him more than a few hours but had obviously accepted him wholeheartedly as one of the chosen people, and were soon giving him the full freedom of the petrolic cosmos with all its coincident privileges. Anyway, it was our distinct pleasure to run into Pete at the Petroleum Club of Los Angeles where he was engaged in divers interesting and altogether delightful pecuniary pastimes involving a skipper, his vessel, and his men.

Among the contending gentry were Bob Smith, the Sun Ray legal light, and possessor of the highest tenor since the demise of Enrico Caruso; O. I. "Tork" Torkelesen, vice president of British American Oil Producing Company, one of the best dressed men in the industry and a proficient performer in the less strenuous or parlor sports, such as dominoes, cribbage, and the baby requires new shoes; Alexander Hamilton Bell, the resourceful drilling contractor who has had more adventures than Richard Halliburton and has done everything but invent the telephone; Ed Bartosh, the good natured Bankline geological whiz who heads the Oil Club and is a stout pillar of the whole petrolic structure. Into this august company, Pete Sharp fitted like one to the manner born. He is, we believe, a consequential attache of the Royal Bank of Canada, and as nearly as we could determine is interested in some way or other in the coupling of financing and oil development in the Dominion. But be that as it may, we found him a mighty enjoyable and interesting companion, and it was easy to see that he had suitably impressed the snug coterie of higher-ups already mentioned. Pete is distinctly *persona grata* down thisaway and is sure of a real welcome anytime he shows up in the vicinity.

Boy *Scouting West Texas*

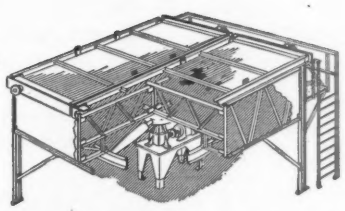
Occasionally we are the recipient of a bit of well done verse of the patriotic type that apparently flows somewhat freely and easily from the pen of one Velle Galle. This lady is a titivater of Erato, the poetry muse, back there in Andrews, Texas, and poetry is not by any means her sole accomplishment, for we find that she has considerable reputation also as an artist-illustrator. Following the trail farther, we learn that our talented correspondent is the wife of an oil man, to wit, Adell Galle, who functions as chief operator at the Fullerton field station of the El Paso Natural Gas Company. He has been 15 years with the company and has never regretted the day that he literally forced Lazy Harris to give him a job by jumping on a truck that was taking a force of men out to a field assignment. Outside of business hours, Adell gives much of his time to the Fullerton First Baptist Church, and we might say our own experience indicates that the most enjoyable moment in church is that interval just after the minister has announced the subject of his sermon and just before everybody starts to cough.

Getting back on the beam, however, Adell is also interested and active in masonry and Boy Scout work and has three fine boys who are being brought up in the Scout tradition. This recalls the sad case of the elderly lady who lost her purse in the railway station in Glasgow, Scotland, and was just looking around for a high building from which to throw herself, when two young boys, the larger one in Scout uniform, came up to her and handed her the missing purse. The lady, of course, was tickled no end that they had found it, and after checking the contents to see that nothing was missing, she offered the older boy a shilling. To her surprise the boy drew back and said, "No thank ye, lady—a Boy Scout can no take money forr doing anybody a service!" The lady hastily stuffed the shilling back in her purse, shuddering over its near loss, and started to walk away when the boy touched her on the arm, and announced, "Lady—ma wee brother's no a Boy Scout!"

Whing-dinging in LA

Immediately following the IPAA convention in Los Angeles, the PESA staged a mixed cocktail party that was one of the most enjoyable affairs we have attended in a long time. Among the interesting people with whom we consorted at this affair were the Kelleys of Hillman-Kelley fame. We had a nice chat with Mrs. Kelley who is a very gracious and lovable lady. We talked, of course, largely about those two irrepressible lads, Larry, the Houstonian, and Jimmy, the Angeleno, and what we ought to do about them, and if we do say so ourselves we have some very good plans all worked out. Then we were introduced to Daughter Mary, and found her generously possessed of the Kelley good looks and friendliness. Grover, the head of the household was there in person, greeting and being greeted by everybody in the place. Meantime, Jimmy was doing his usual excellent job of circulating. This lad, incidentally, knows as many people in the California oil industry as any man in it. Over in a secluded corner at this same party we discovered a bevy of Gillilands, obviously having a wonderful time. There was Joe, the La Habra Heights Beau Brummel himself, with whom we used to have important business dealings way back when knighthood was in flower. Along with him was Mrs. Gilliland, an attractive lady, flatteringly eager to listen to our inanities, and kind in her appraisal of our Whittier offspring. Completing the group were Son Dan, a tall, good-looking youngster who is now managing the Gilliland interests so that pop can give more time to the less strenuous aspects of life; and Mrs. Dan, young, vivacious and charming. We might mention in passing that hovering in the background was that gay Lothario, Al "Dutch" Zwerneman, who is seen more places than a congressional candidate, and enjoys his association with the oil business about as fully as anyone we know. We can hardly close this report without apologies to the hundreds of other nice people we met, and without voicing our thanks to PESA for their hospitality.

Another grand party was staged by Standard Oil Company at the University Club in Los Angeles during the API spring meeting, and John Thacher, Warren Johnson, and all their aides are to be congratulated on an excellent job of hosting. It seemed as if everybody was there, and there was more reuniting and reminiscing than you would find at an Iowa picnic. Anyway, it was all very exhilerating and enjoyable, and we enjoyed it.



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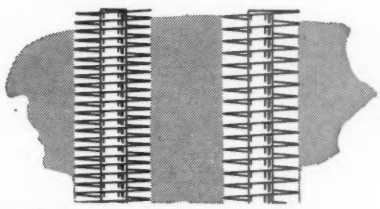
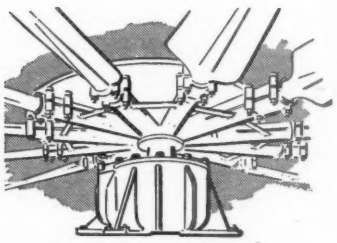
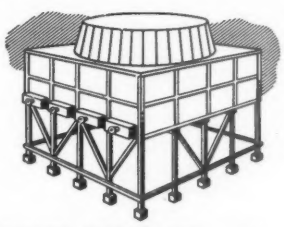


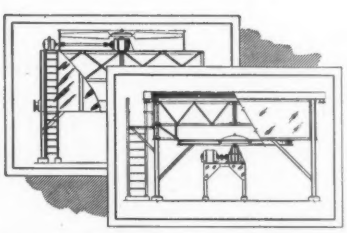
EFFICIENT FINNED TUBES . . . pressure bonded fins on tubes give high level heat transfer not dependent on solder joints. Various fins, tubes and headers available to meet any application.



PROVEN MECHANICAL EQUIPMENT . . . multibladed fans and rugged Geareducers team up to give quiet, smooth and dependable operation . . . regardless of weather or location.

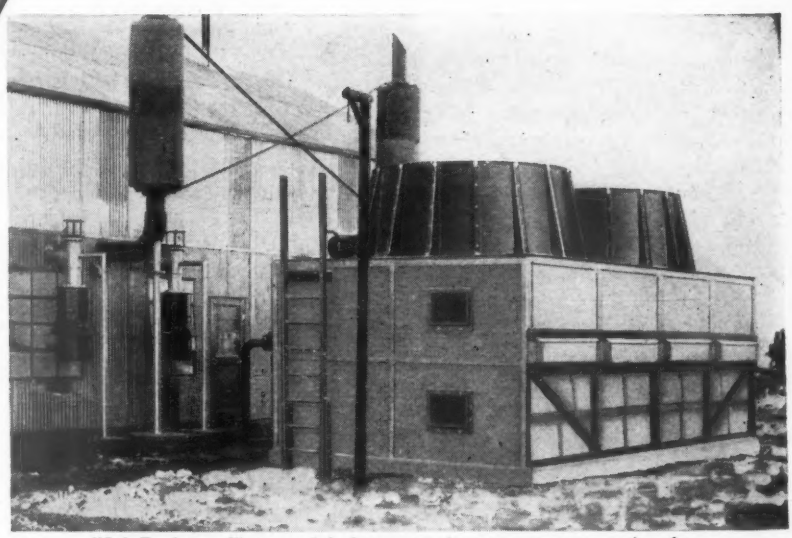


ALTERNATE MATERIALS . . . where corrosion is a problem, asbestos-board casing on a redwood frame requires little maintenance. Redwood, standard in cooling tower design, gives strong, durable and rigid support.



COMPLETE STANDARD LINE . . . induced draft or forced draft — portable or stationary — steel or redwood — various fin and tube materials and arrangements are offered by Marley to meet any application — usual or unusual.

Features like these . . . make MARLEY DriCooler® "JOB-ENGINEERED"



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After considering all factors, such as the fluids to be cooled — first cost — horsepower cost — weather conditions — corrosion and many other factors, Marley can make the best and most economical recommendation for your job.

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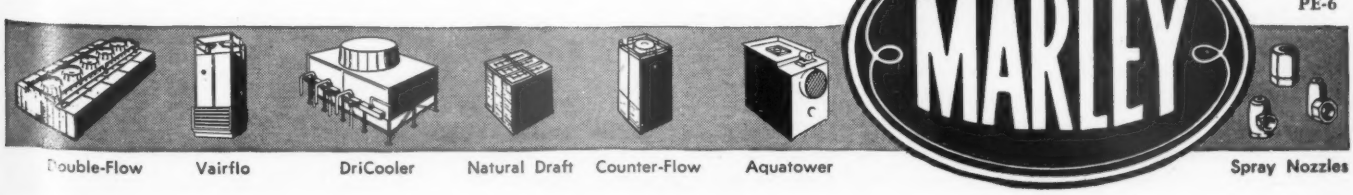
Let your Marley Application Engineer work with you from the "blueprint" stage on. Write, The Marley Company, Inc., Kansas City 15, Kans.



PE-6

LETTERS
to the Editors

More Details on Synthetic Fuel Projects

To the Petroleum Engineer:

The first of the two installments of the article, "Significant Research in Petroleum Recovery," prepared by me and appearing in *The Petroleum Engineer* for February, 1950, mentions research work under way by the U. S. Bureau of Mines, with special reference to Report of Investigation 4458. Although the article was intended to include selected projects only from the various organizations cited, it appears desirable to elaborate more fully on the total program of the Bureau for the purpose of clarification.

I have been advised by R. A. Cattell, Chief, Petroleum and Natural Gas Branch, Washington, D. C., that research on petroleum and natural gas by the U. S. Bureau of Mines has been supported for many years by annual appropriations under the title, "Oil and Gas Investigations." The Synthetic Liquid Fuels Act, approved April 5, 1944, authorized the experimental work on production of synthetic liquid fuels from coal, oil shale, and other substances. The extension of the Synthetic Liquid Fuels Act was approved March 15, 1948. The Gavin Amendment thereto provided "that not to exceed $1,000,000 of the amount authorized by this Act may be applied to a program of production research on secondary recovery from stripper oil fields and in refining processes." As the Synthetic Liquid Fuels Act, as extended, runs to April 5, 1952, the $1,000,000 was spread over the remaining period, at a rate below $300,000 a year. That money has supplemented the "Oil and Gas Investigations" appropriation in financing the Bureau's petroleum research. Use of synthetic-liquid-fuels money in petroleum studies is limited to the phases designated in the Gavin amendment.

The work of the Bureau on petroleum, natural gas, and helium is conducted separately from the work on synthetic liquid fuels. However, the chief of the Petroleum and Natural Gas Branch also plans and coordinates the retorting and refining phases of experimental work on oil-shale, which constitute a part of the synthetic-liquid-fuels program. This branch is not concerned directly with that part of the synthetic-liquid-fuels program involving the production of oil from coal.

Bureau of Mines R. I. 4458 contains Part III on Liquid Fuels from Agricultural Residues, and Part IV on Secondary Recovery, and Petroleum Chemistry and Refining Research, of the report of the Secretary of the Interior for the calendar year 1948, required by the Synthetic Liquid Fuels Act. As the law provides for an annual report by the Secretary covering only the work authorized by that Act, as amended, Part IV discusses only those parts of the petroleum research that were carried on with funds made available by the Gavin amendment. More than two-thirds of the petroleum work, including all the work on primary production, is financed from "Oil and Gas Investigations."

Part I of the Secretary's report for 1948 (R. I. 4456) covers "Oil from Coal," and Part II (R. I. 4457) covers "Oil from Oil Shale." Each of the three reports of investigations contains pages I to XVIII, which give a summary report of the entire program authorized by the synthetic-liquid-fuels act.

An excellent picture of the Bureau's work on petroleum is contained in the series of articles, "History and Analysis of Bureau of Mines' Petroleum and Natural Gas Division," written by Ernestine Adams and printed in *The Petroleum Engineer* from December, 1948 to March, 1949.

Overall pictures of the Bureau's work on petroleum and natural gas from July 1, 1947 to June 30, 1949, including that financed from the "Oil and Gas Investigations" appropriation as well as that financed from the part of the "Synthetic Liquid Fuels" appropriation that was made available by the Gavin amendment, are given in the following:

Bureau of Mines Information Circular 7532, Report of Petroleum and Natural-Gas Branch, Fiscal Year 1948, by R. A. Cattell and others.

Bureau of Mines Information Circular 7551, Report of Petroleum and Natural-Gas Branch, Fiscal Year 1949, by R. A. Cattell and others.

The report of the Secretary of the Interior on the synthetic-liquid-fuels program in the calendar year 1949 consists of four parts, as follows:

Part I—Oil from Coal (Report of Investigations 4651)
Part II—Oil from Oil Shale (RI 4652)
Part III—Liquid Fuels from Agricultural Residues (RI 4653)
Part IV—Oil from Secondary Recovery and Refining (RI 4654)

Each part of this report contains pages I to XXII, which give a summary of the entire synthetic-liquid-fuels program during the year. In the text of Part IV, following that summary, there is a discussion of the Bureau's work on secondary recovery and refining processes authorized by the Gavin amendment, but, like R. I. 4458, R. I. 4654 discusses less than one-third of the Bureau's petroleum research, because more than two-thirds of it are entirely apart from the synthetic-liquid-fuels authorization and appropriation.

If the Congress follows the recommendations of the Bureau of the Budget in making appropriations to the Bureau of Mines for the fiscal year 1951, the money for petroleum research will be consolidated under the sub-heading, "Petroleum and Natural Gas" in an appropriation known as "Conservation and Development of Mineral Resources." Beginning with 1951, the new appropriation structure probably will eliminate the difficulties in reporting that have arisen from the provision of law that requires a report on a calendar-year basis covering a part of the work on petroleum, which tends to become confused with the report on a fiscal-year basis covering all of that work.

H. H. Power

University of Texas,
Austin, Texas.

Likes Refining Articles

To The Petroleum Engineer:

I wish to express my thanks to you for the type of articles you had in the March issue of the Refining and Gas Processing Section. "Sparks in the Plant", "Extraction of Dust and Mist", "Figuring Air Receiver Pump-up Time", "Water Cooling Towers", "Stuffing Boxes for Centrifugal Pumps", "Rotary Filters Added to Propane Dewaxing Plant" were all of interest to us mechanical engineers. I am hoping you will publish more articles of this character.

Robert H. Wehrle,

Euclid, Ohio.

Pipelining Edition

To The Petroleum Engineer:

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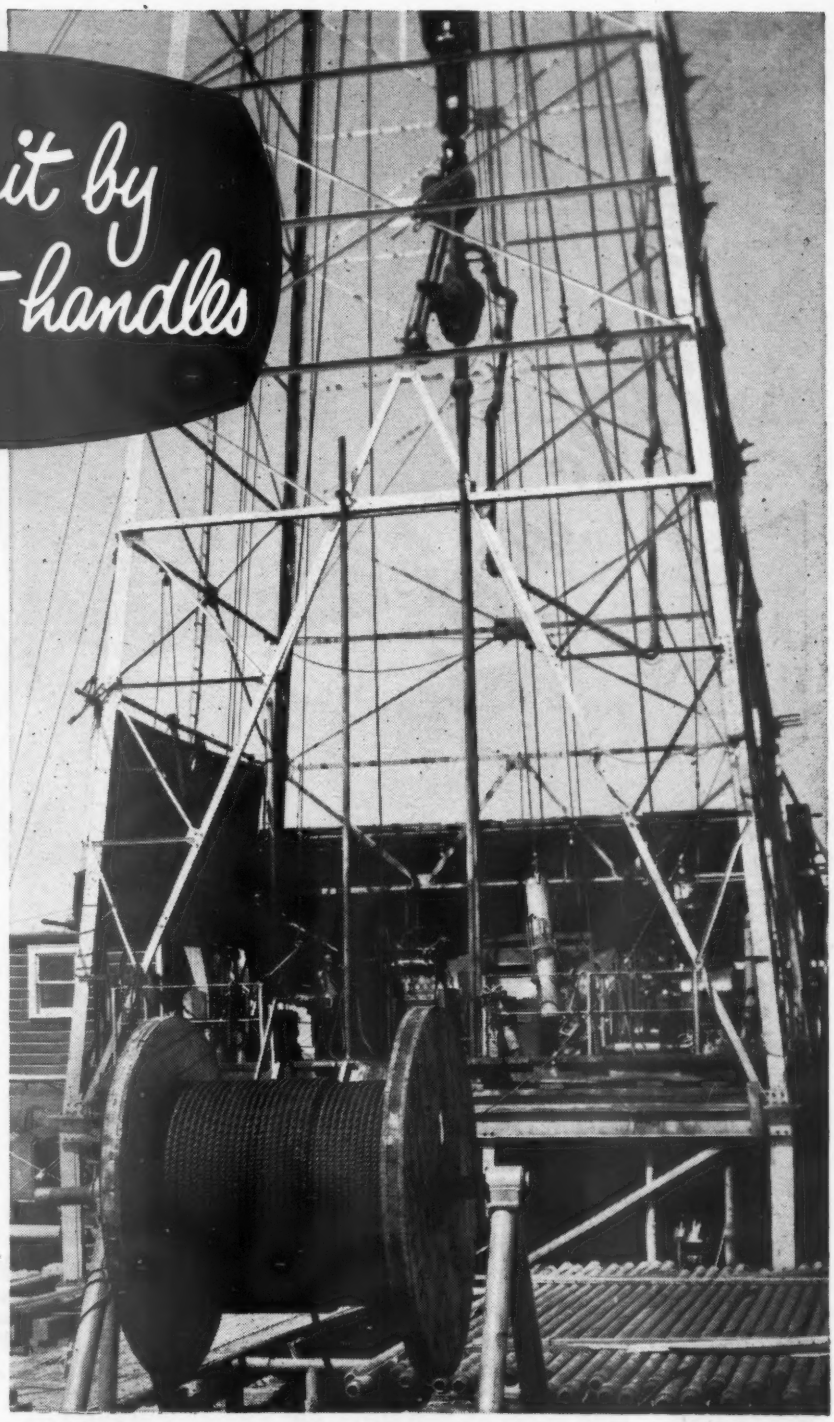

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Alberta Inter-Field Gas Lines Limited is most anxious to obtain a year's subscription to your publication and particularly to get your March issue, which, I understand, is your annual pipeline issue. .

Please advise annual rate of the subscription and method of payment preferred.

John W. Proctor,
General Manager
Alberta Inter-Field Gas Lines, Ltd.,
Edmonton, Alberta.

Editor's Note: *Oil and Gas Pipelining of The Petroleum Engineer is $1 for one year; $2 for three years, by check, money order, or cash.*

Edmonton It Is

To The Petroleum Engineer:

In the section "What's Doing In Drilling" in the March issue of *The Petroleum Engineer,* your writer places the Redwater oil field in Calgary, Canada. Let me assure you that this field has been often and loudly claimed by Edmonton as an "Edmonton field", and rightly so, since it is only 35 miles from Edmonton and nearly 235 miles from Calgary.

This may seem to be a small point, but Edmonton and Calgary are hot rivals for recognition as the centre of the oil industry in Alberta. Radio stations from both cities identify themselves with the name "The Oil Capital of Canada", and since the decline of the Turner Valley field near Calgary and the development of the Leduc and Redwater fields near Edmonton, it seems that Edmonton is forging ahead in the tight race for recognition. Calgary has the definite advantage of being first in the development of oil fields and most of the major companies have headquarters there. A new petroleum building being erected in Calgary will also give the city a definite spurt in the race.

I trust that this bit of background will be of interest to you and your very good publication. *Victor E. Bohme,*
Edmonton, Alberta,
Canada.

THE Petroleum Engineer

JUNE, 1950

Volume XXII No. 6

The Oil Industry Fights for Survival

The Historic Freedom of the Petroleum Industry is Endangered by False Conceptions and Misunderstandings—Here the President of a Large Company Explains That Unfair Criticism Must Be Met.

WALTER S. HALLANAN*

THROUGH the National Petroleum Council, the industry has given a very impressive demonstration of the fact that it is fully aware of its public responsibilities. It has been conscious that with the strength and power that have been developed in the achievement of its record level of productivity, there have come certain inescapable responsibilities to those whom it serves. It is now recognized that petroleum is the nation's "life line" and is the most vital essential of our domestic economy and national security. Because of that fact the oil industry's public obligations have been greater than those of any other segment of our industrial economy.

It is a source of tremendous gratification to be able to say that the oil industry has met every test. The record of its outstanding accomplishment in the public interest stands like an unconquerable fortress in the path of its detractors.

The pace has been swift and the pressures terrific. All segments of the industry and all units of each segment have had so many individual problems of their own, in meeting the enormous demands of the public and the government, that there has been a natural tendency even among ourselves to appraise inadequately the overall achievement of the last 25 years. When we review the total result of the combined and unified efforts of the producer, the refiner, the transporter, and the marketer, the conclusion cannot be escaped that a veritable industrial miracle has been wrought. I think we owe it to the country and to ourselves to make certain that there is public realization of the enormity of the job that has been done.

In the last quarter of a century, the oil industry has plowed back twenty-five billion dollars—an average of one billion dollars a year—into the discovery and development of new reserves. In recent years, expenditures for finding and developing crude oil have averaged nearly two billion dollars a year, representing approximately 60 cents out of every dollar received from the production and sale of crude oil in this country. In the last 25 years the industry has drilled 640,000 wells for a total footage of two billion feet, equal to 50 holes through the center of the earth.

That program has produced forty-eight billion barrels of new reserves, more than one and one-half times the national consumption of thirty-one billion barrels, including the demands of the greatest war in history. The industry fueled that war, supplying almost 90 per cent of all the oil used by the United States and its allies, and it wound up the quarter of a century of outstanding achievement on January 1st of this year with the largest reserves in our history. The high water mark of the industry's achievement is reflected in the fact that the oil and gas resources of the country have been developed to a point where they equal about one-half the total mineral wealth of the nation. Through its 35,000 separate units, the industry directly employs almost 2,000,000 persons, and it is the foundation of the economy of many states and communities.

In accomplishing this miracle of production and expansion, the oil industry has constantly developed new products, improved their quality, and furnished them to the public at prices consistently lower than those of other commodities. We submit that these achievements have benefited the entire nation and have given it a sense of security that could not exist without adequate oil reserves and productive facilities.

We can take pride in the realization that the oil industry has been the torch bearer in the most remarkable advance made by mankind within recorded history. The birth of the industry in 1859 was the spark that touched off the industrial revolution that has brought to Americans higher standards of living than have ever been enjoyed by any people on the face of the earth.

Oil has given light, mobility, and

†Presented at the thirty-eighth annual meeting of The Western Petroleum Refiners Association, San Antonio, Texas.

*President, Plymouth Oil Company, Pittsburgh, Pennsylvania.

speed to America and brought to us a degree of prosperity, comfort, and luxury beyond the conception of those who lived less than a century ago. It is today America's first and last line of national defense. In all humility we can say that if this country is as secure and formidable upon all other fronts as it is in its reserves of oil, we need have no fear of the armed might of any nation on earth.

More even than these material achievements, the oil industry has produced the highest type of American citizenship. Whenever we see anyone in the fields from a "roustabout" to a drilling superintendent, anyone on a pipe line from a gager to a line walker, anyone in a refinery from the chemist to the man on the catalytic cracker, anyone at the filling station pump—whenever we see any of these representatives of the oil industry, we know that we are looking upon upstanding, God-fearing citizens. Whenever and wherever you see one of these men, from the highest to the lowest, you will find the embodiment of real American patriotism that has no truck with Communism or any other foreign ideology. He is a real American, and proud of his birthright.

Now, all of these things did not just happen. Our reserves of oil and the facilities to produce, process, and distribute those reserves have not doubled and trebled and quadrupled through fortuitous circumstances. The development of our modern system of transportation, with its vast network of highways and skyways that bring 150,000,000 people close together in their daily lives and pursuits, was not a matter of chance. There was a purpose in this development, and there was a plan to implement that purpose.

You and I know that the gigantic demands upon the oil industry during this expanding era could not have been supplied by individual or even group effort. No one segment of the oil industry could have shouldered the enormous burden of providing the basic essential of this great development. The producer alone could not have done it; neither could the refiner, the transporter or the marketer. The "wildcatter," limited to his field of discovery, could not have done the job alone, and neither could the major companies or a combination of all the independents.

It was a task that required Herculean effort on the part of all. It demanded teamwork that developed unusual skills and techniques and welded them together into a single unit whose operations were perfectly coordinated. We have had that kind of teamwork in the oil industry. Every individual, every unit, every segment has had a shoulder to the wheel. Their collective energies, intelligently channeled and directed, have made of the oil industry an outstanding symbol of the success of our American system of free enterprise.

Now, incredible though it seems, there are some people who would like to break up this team. There are some who, in the face of this marvelous record of achievement in the national interest, use the prestige of their high position to give widespread publicity to a false charge that the industry has taken unfair advantage of "loopholes" in the tax laws. There are still others in high places who have revived the thoroughly discredited old bugaboo that we are "running out of oil," thereby inferring that the oil industry has not done the job of keeping its discovery rate equal to consumption.

There just is not one word of truth in these accusations. They will not stand the light of fact and of the record any more than a house built upon the sands will stand before the force of a tornado. But we must be aware that many uninformed persons will be disposed to accept these "smears" as fact. It is our job—our responsibility—to answer these traducers of a great American enterprise. It is not a job to be done with the restraints of diplomatic niceties. The time has come to take off the gloves and get down to bare knuckles. We must not deceive ourselves about the harsh realities. We must realize that the chips are down. This is in reality a battle for survival.

Those who would break up this all-American team, which has been the bulwark of our nation in war and peace, are motivated by a single purpose. That purpose is to have the government take over control of the oil industry. This would not occur in one real swoop because they know the people would never stand for such a prostitution of sound American principles. Their plan is to accomplish by slow and insidious processes what they cannot achieve by direct and frontal action.

We all know that this purpose is denied, but the frequency and the vehemence of these protests are in themselves a matter of the greatest suspicion. They protest too much and too loudly. In the light of the philosophy of these ideologists, as expressed in their constant reaching out for more and more power over the American economy, their denials are as empty of conviction as their accusations against the oil industry are empty of fact.

We know that they want the driving reins put in their hands. Although many of them would not know a rotary rig from a "cat cracker," they have a covetous anxiety to manage and direct the affairs of the oil industry from top to bottom. Their ultimate purpose is to socialize the industry, and it is only the most naive who fail to discern this over-all plan. Every step in this direction is disguised by the thin veneer of the high-sounding phrase, "public interest." The truth is that the accomplishment of their purpose would be America's darkest hour since Valley Forge.

Whenever the turning of a valve in Texas or Oklahoma or elsewhere has to await a directive from Washington, this nation will stand defenseless before the world. We will have turned the clock back 100 years. God grant that such an evil day shall never come to this land of ours.

These sinister assaults complicate the difficulties of the oil industry at a most unfortunate moment. They come at a time when the industry is sorely beset by the most critical and complex problems in its 90-year history. We are conscious as we meet here today that despite the industry's remarkable record of achievement over a period of 90 years, we cannot rest upon our oars. We must pull upon those oars harder than ever before—and we must pull together. Although our record of accomplishment in the public interest is a source of pride, it is of no material help in solving the new problems of the present day. We must work more earnestly and diligently than ever before, and if we are to have any measure of success we must reach a new high point in industrial statesmanship.

Of course, we recognize that any industry that constantly moves forward in meeting the day-to-day challenge of a dynamic and expanding economy must expect to be beset by new and serious questions at every turn. We are accustomed to that, and we recognize it to be an essential part of our strength and vitality. But what we must realize now is that never before have so many serious challenges been upon the industry's doorstep at any one time. Never before have we been called upon to fight simultaneous battles upon every front.

We are confronted today with the realism of an enormously increased world production and a sharply contracting market for American oil. America has been the leader in the sphere of world oil since the birth of the industry. It has been our proud boast that we had more proved reserves within the United States than in all the rest of the world. Many nations depended upon us for oil, and we stood unchallenged as the world's largest exporter of petroleum. We have

become so accustomed to this position of superiority and dominance that many of us have taken it for granted that this condition would always exist. Even in the face of the realities of this foreboding hour, there are many who are unwilling to recognize the serious challenge to our position of world leadership.

There is no security in the complacency of a mental Maginot Line based upon the fact that the United States is the largest producer and consumer of oil in the world. Although there may be some comfort in this knowledge, we must not permit ourselves to be blinded to the grim reality that we no longer have the largest proved reserves in the world, and that we are no longer the largest exporter of oil.

The facts are that the United States has become an importer instead of an exporter of oil. This is a circumstance of the most serious importance to the domestic industry, especially to the independent and individual producers and refiners, who constitute the very backbone of America's life line of oil.

I have said it many times, but I want again to emphasize that there is no security in foreign oil in any hour of national emergency. We are leaning upon a broken reed when we place dependence upon reserves that lie across the seas. We know that when the hour of emergency comes to our door, we will have to depend upon our own oil reserves here at home. And these reserves would be without immediate or practical value unless we have a strong and healthy industry to produce, process, and distribute them.

We must recognize that 70 per cent of the oil reserves of the world now lie outside the United States. The important and ominous thing about this is that the actual production from these foreign reserves amounts to only 40 per cent of the world's total. The natural result is that there is a strong demand and an intensive effort to increase the productive rate in foreign countries.

The curve of foreign production has been going steadily upward, and there is no reason to believe that it will be halted. On the other hand, there is substantial basis for the fear that the increase will be accelerated in the years immediately ahead. The economic and political pressures for increased foreign production are tremendous. They have their repercussions in the chancelleries of the world. They are the subject of serious discussion at every international round table.

As the industry seeks some solution to this most disquieting situation, which has so many deep-seated ramifications in radically disturbed world politics and economy, it is called upon to build up a reserve productive capacity, fantastic in proportion as compared to anything known in the past, in order to insure an adequate, *immediate* supply of oil and its products to meet any national emergency.

As an integral part of the same program of providing national security, the industry is asked to accelerate its exploratory and development programs in order to assure a continuation of the increase in petroleum reserves so that America may be safe and self-sufficient in its most important natural resource. This calls for a corresponding degree of expansion in transportation and refining facilities.

These are tremendous tasks. They call for capital expenditures running into billions of dollars. They demand the highest order of organization and of technical skill. They are fraught with all of the extreme perils that are a part of the most hazardous business in the world. Their initiation and prosecution require a vision that places no limitation upon the economic frontiers of our country. These would be gigantic undertakings under the most favorable circumstances.

Unfortunately, the industry is not being permitted to approach these great tasks and responsibilities in a free and cooperative atmosphere. It seems that some new artificial barrier is thrown up across the road ahead almost every day. The State Department is committed to a determined and aggressive program of increasing oil imports far above present ruinous levels. This European-minded agency of our Government seems more interested in developing the economy of the Middle East and fattening the pocketbooks of the shahs than in the preservation of American business enterprise and American labor. They have said that if unrestricted imports are hurtful to an American industry, that is just too bad—it can't be helped. The imports must come first, under international obligations. There seems to be no recognition in that Department that the real kings of this world are not in the palaces of Persia but in the humble homes of this free country.

Since 1946 world oil production, exclusive of Russia, has increased 1,590,000 barrels daily. In the same period, production of domestic oil, which had risen approximately one million barrels daily by the end of 1948, now shows an increase of only 293,000 barrels per day. Eighty per cent of the total increase has come from beyond our shores, and the figures on our domestic cut-backs and the decline in our exports tell an eloquent story of who is absorbing this enormous increase in foreign oil. If you will add the curtailment in domestic production to the loss in American oil exports in the last three years, you will get a figure that almost exactly equals the increase in foreign production.

Shut-in, or excess productive capacity of over a million barrels per day, has been built up in this country since the war at a tremendous sacrifice by domestic oil producers. This stockpile of reserve productive capacity represents a great bulwark for defense in a national emergency; however, to prolong or unduly increase such sacrifice will weaken the very backbone of our defense through the destruction of thousands of oil producers in this nation upon whom our permanent security depends.

In the first ten weeks of this year, gross income from domestic oil pro-

IPAA Predicts Higher 1950 Demand

The Economics Committee of the Independent Petroleum Association of America has made its first report on oil supply and demand. The highlights of this forecast may be summarized as follows:

1. Total U. S. demand for all oils, domestic and export, for the calendar year 1950 is estimated at 6,468,000 bbl per day. This would be an increase of 349,000 bbl daily or 5.7 per cent over actual 1949 demand.

2. Domestic demand for all oils in 1950 is estimated to be 7.3 per cent higher than in 1949 whereas exports are expected to decline by 22.6 per cent.

3. The percentage changes in the total demand for products for 1950 as compared with 1949 is forecasted as follows: Gasoline +3.4 per cent, kerosine +12.8, distillate +15.6, residual +4.2, other +2.1, a total of +5.7 per cent.

The Committee's estimates of total required supply average as follows: First quarter 1950, 6,209,000 bbl a day; second quarter, 6,390,000 bbl a day; third quarter, 6,449,000 bbl a day; fourth quarter 6,643,000 bbl a day; and first quarter, 1951, 6,638,000 bbl a day.

The domestic crude demand is set at an average 5,130,000 bbl daily compared with actual production averaging 5,040,000 bbl daily in 1949 and 5,520,000 in 1948.

duction was 102 million dollars less than the gross income for the comparable ten weeks period in 1949—an average loss of a million and one-half dollars daily, resulting largely from forced cut-backs in domestic production. This loss exceeds one-half billion dollars on an annual basis.

All of the burden of this greatly increased output from abroad, much of which has been financed by the dollars of American taxpayers, is being placed on the shoulders of our domestic industry. It is true that our back is strong and broad, but somewhere there is a limit to the load that we can carry. There is always a last straw, and we have just about come to that point now.

On January 23 last, the President of the United States launched an attack upon the oil industry's depletion allowance under our Income Tax Laws, in the following language:

> "I know of no 'loophole' in the tax laws so inequitable as the excessive depletion exemptions now enjoyed by oil and mining interests."

The Treasury Department followed this by urging Congress to reduce the depletion allowance on oil development, which has been accepted as sound public tax policy for the past 24 years.

These attacks come at a time when we are on notice that the industry must be prepared to supply an additional 2,000,000 barrels of oil daily to meet any national emergency. In initiating and pressing this unfair and destructive program, the President has regrettably lent the great prestige of his office to a "smear" attack upon the oil industry. All of you remember the great publicity that came from the White House when this attack on depletion was launched, that an unnamed person, so the President said, had received a net income of $5,000,000, but, because of the depletion allowance on his oil properties, had paid no income taxes whatsoever.

The most charitable thing I can say about this specific instance cited by the President is that it just couldn't be true, and it isn't true. We do not need to know the person involved or any of the facts in the case in order to challenge the assertion that the depletion allowance provided for the oil and gas industry made it possible for him to escape taxation entirely on $5,000,000 of income. If this anonymous person escaped taxes it was most certainly not because of the depletion provision, because we all know—and certainly the President should know—that depletion is limited by law to 50 per cent of net income.

The President said—and the left wing columnists and commentators have parroted the assertion throughout the country—that the oil industry was escaping hundreds of millions of dollars in taxes annually by taking advantage of a "loophole" in the tax statutes. Now, the very term "loophole" implies that cunning persons had found a weakness in the law that had not been intended by Congress, and had proceeded to take unfair advantage of the Government.

There is no more truth behind that implication than in the statement about the man with an income of $5,000,000 who paid no Federal income taxes. The depletion provision was written into the revenue laws by Congress in 1926, after the most thorough and exhaustive investigation. It was determined as fair to the oil producer as a method of recapturing his investment and avoiding a tax upon his capital, and it was also determined to be vitally necessary to encourage people to assume the risks of exploring for oil so essential to the national security. Time and again since 1926 succeeding Congresses have studied the question and have reaffirmed it as a sound policy.

In the face of those facts, the public is told in sensational language that the oil industry has been exploiting some "loophole" in the tax laws. In fact we are made to appear as flagrant "tax dodgers." The truth is that the oil industry is already burdened with taxation. It is carrying more than its share of the burden. The record shows that a greater percentage of the oil industry's gross income goes for taxes than the average for all American industry. It also leads the way in putting net income back into expansion and development. The oil industry pays out only 40 per cent of its net profits in dividends to stockholders, while the average for all other industry is 60 per cent.

While the State and Treasury Departments pursue their attacks against the industry upon the import and tax fronts, the Department of Justice is assiduously seeking in the courts to nullify titles to offshore leases acquired in good faith from Texas, Louisiana, California, and other coastal states. We are called "trespassers," although we hold titles that were acquired at a cost of many millions of dollars, and although we have been diligently trying to carry out the request of the Defense Department of the government that the oil resources of the tidelands be developed as quickly as possible. It is only one short judicial step from "paramount rights" over oil reserves of the tidelands to the same kind of dominion over the oil and other natural

Pew Gets Vermilye Medal. J. Howard Pew, left, director and former president of Sun Oil Company, has been selected to receive the Vermilye Medal, which is awarded biennially by the Franklin Institute, Philadelphia, for "notable leadership in the field of industrial management." President of Sun Oil Company for 35 years prior to his retirement in 1947, Pew was a director of the American Petroleum Institute for 29 years and last year was awarded its most coveted honor, Gold Medal for Distinguished Service.

resources of the uplands. And our present-day Supreme Court frequently walks with a long stride.

Then concurrently we observe that the Federal Power Commission is attempting to fasten the dead hand of government control upon the natural gas industry from the well mouth to the domestic meter. If natural gas is to be controlled by a Federal Commission, you can be assured that oil will be next on the agenda. By their very nature the two elements are inseparable, and as a practical matter of administration the government cannot control the gas that comes out of a distillate well without controlling the oil that comes out with the gas.

The determined effort to establish absolute Federal control over the production, development, and price of natural gas, and upon its transportation and distribution, is just the entering wedge to fasten the same kind of governmental domination over every branch of the oil industry from the drilling rig to the filling station pump. It would result in a peacetime OPA with rationing and Gestapo tactics. The oil industry would then be throttled by nonsensical directives from political incompetents in Washington. That would have the effect of stopping the industry dead in its tracks in its efforts to meet the needs of national security and the demands of an expanding economy. Consumers would pay a frightful price in costs and shortages for such folly, and the nation would pay an even greater price in serious impairment of our national defense. Not only as oil men but as patriotic American citizens, we must take care that this shall never happen.

At the same time that all of these assaults against the industry are being pressed with great vigor and determination, there has been launched a spurious propaganda campaign designed to scare the public into believing that we are "running out of oil." At Chicago, only a few months ago, the vice president of the United States added his voice to this propaganda effort. He said that we have only enough oil in this country to last 13 years, leaving the impression that at the end of that period we would be totally bankrupt in oil reserves.

If it were just Alben Barkley, the individual citizen, who was involved, I could be inclined to ignore such an absurd statement; but when a wholly unfounded statement respecting the oil industry goes out under the sponsorship of the second highest official in the country, I think we must view it as a serious matter.

The facts of the matter certainly must have been known to the vice president. They are matters of record and of wide publication. They are on file with half a dozen or more government departments and bureaus. Those facts show that after furnishing the oil to America and its allies in the two greatest wars in human history and after meeting a domestic demand that expanded beyond all calculation, we still had on hand at the moment Barkley spoke the greatest reserve of proved petroleum resources in our history.

In the year of 1949 we added more than a billion and a half barrels to our reserves—and for the first two months of 1950 the discovery rate has been well ahead of last year. Each year we are discovering more oil than we produce, and the reserves continue to mount, giving increased assurance that all petroleum demands of the foreseeable future will be met with some to spare.

The vice president merely picked up an old, old story, dusted it off and endeavored to present it as something new and sensational. We know that this story that we are "running out of oil" has gotten into the classification of an old wives' tale. It is almost as old as the industry itself, and I suppose we will always have the pessimists and doubting Thomases who see doom just around the corner.

To Barkley and the other prophets of doom and shortage, who have predicted that the country faced an oil and gas famine, the oil industry has given the answer that on the dawn of this new year, this nation had the highest reserves of oil and gas in its entire history. That is a record that speaks for itself.

There is another feature of this propaganda campaign that has placed the oil industry in an entirely false light. Because of the success of a very limited number of persons in the industry, it has been made to appear that all one has to do to discover oil is to drill a well almost anywhere. In this connection, may I say that it has been no contribution to the public relations of the industry to have the flamboyant Hollywood publicity about the participation of some of its well-known citizens in drilling for oil.

We know, of course, that when a 10-bbl well in Texas goes through the Hollywood publicity catalyst, it comes out at not less than 10,000 bbls, and is broadcast throughout the land as the discovery of a "gusher," which everyone in the oil business knows is no longer existent. We are likewise aware that with the greatest of ease, this same catalyst can turn an actual investment of $10,000 into one that goes before the public as at least a million.

Now, these attacks that I have summarized are just a few samples of the weapons being used in this all-out assault upon the industry, which has met its every public responsibility since 1859, and which has developed within its ranks the highest and most patriotic type of American citizenship.

For a moment let us detach ourselves from the oil industry and appraise these problems and their implications as patriotic American citizens. We cannot view them in any calm and objective light without coming to the realization that if the philosophy represented by the assaults now being made upon the oil industry had been national policy for the last 50 years, you and I would not be meeting here today.

We know that if the industry had been compelled to function without the incentive of the depletion allowance, with unrestricted imports, with its titles jeopardized by governmental action and under a continual "smear" attack from political and economic propagandists — we know that had those conditions existed back over the years, we would have lost the first world war and we would have been completely annihilated by our enemies in the second world war.

We are most deeply and seriously concerned now about what is going to happen in a third world war, when and if it comes to our door. In the light of the twilight zone between peace and war in which we live from day to day, we must realize that we are not merely in a battle for survival of the oil industry. It is, in fact, an Armageddon of the American people.

This matter of survival as a free and independent industry is not just a problem of the petroleum business. It is a great national problem that involves the destiny of every citizen of this country. More than ever before, oil is our first and last line of defense in any war of the future.

It has been almost two years ago that the late Secretary of Defense, Honorable James Forrestal, pointed out to an Armed Services Committee of Congress that in order to meet the petroleum demands of any future war the nation must have an excess productive capacity of an additional 2,000,000 bbls of oil per day. That is over and above the ready daily production to meet our domestic requirements. That is twice what we had when Pearl Harbor was attacked more than eight years ago. That estimate was made in the light of conditions existing at that time. We know there have been many startling developments in the field of military weapons in the last two years, and it is very likely that the Defense

Department has since raised its sights as to the oil requirements of another war.

We are slowly and painfully, but nonetheless certainly, climbing the hill to reach that goal fixed by those charged with the national security and defense. After taxing our productive facilities to the utmost to meet the incredible postwar demand, we are now building up a healthy surplus of productive capacity. We are increasing it somewhat from month to month, but how long is it going to take us to attain a cushion of safety if the industry is to be continually harassed and shackled?

My friends, do you realize that there has not been a day—not one single brief moment—since the oil industry was removed from the straitjacket of OPA price control four years ago, that there has not been some kind of Congressional or departmental investigation of the petroleum industry going on in Washington? During most of that time there have been from two to six of these investigations in progress at the same time. The oil industry seems to be the most accessible public target. The patient is obviously possessed of amazing recuperative powers, else it would long since have died of acute diagnosis. Many of us have been called upon to spend much of our time in Washington, going from one committee and commission to another, when the time could have been more profitably spent in doing the job that the national security demands. We remember that at one time, three years ago, there were more than 20 bills in Congress that proposed varying degrees of Federal control over the oil industry.

So far we have managed, by fighting on every front, to retain our freedom. But the pressures for government control have not been relaxed. They have been increased both in number and intensity. We can make up our minds that if we are to remain free we are going to have to fight, and we are going to have to fight as we have never fought before.

We should be on notice that the disappearance of self-reliance and its replacement by an all-powerful and all-providing government has always been a certain sign of decadence of free institutions.

The accomplishments of the free oil industry prove the case for free enterprise most convincingly. Free opportunity has created the highest standard of living and the greatest area of freedom ever enjoyed by any people. That is the record of 90 years of freedom and action.

To explain away our accomplishments, the critics say we have been the creatures of good fortune. We were lucky. They say America is favored by large accumulations of natural resources—of coal, iron, oil, fertile lands, climate—placed here by nature. We live in a Garden of Eden. Reach out your hand and the fruit drops from the tree.

We have *no* monopoly of the world's resources. Russia and her satellites, for example, have greater resources of many metals. The Middle East has greater reserves of crude oil. The United States is a "have-not" nation for nickel, natural rubber and many other raw materials. But we have combined our human resources and our natural resources in a new, revolutionary way.

Let's take just one resource—petroleum. Crude oil is found in many parts of the world. Its known use goes far back into antiquity. The American Indian knew of petroleum and used it as a medicine. The Middle East—cradle of our civilization—has been sitting on vast reserves of petroleum for thousands of years. The oil might have lain there for thousands of years more, creating nothing, if it had not been for American capital, American equipment, and American enterprise. The oil resources of the Middle East lay idle until Americans did something about them.

There are also great reserves of oil in Russia. For 32 years the Russian oil resources have been in the hands of Communist dictators. The Russian dictators do not believe in individual freedom or enterprise. They operate on a super-plan that is made to work at the point of a gun—under the lash of the whip—and the threat of concentration camps.

Russian oil has not eased the way of life for Russians during the 32 years of the Communist dictatorship. On the other hand, the American oil industry has made phenomenal progress in every direction during the past 32 years. This progress is the American revolution—created by independent business men—with the freedom to make their own plans—and the opportunity to act on them.

That is the record of what the oil industry has accomplished under the incentive and encouragement of a political climate of freedom. Given the opportunity to work in the same kind of atmosphere, the industry will find a solution to the great problems of the hour.

It has been demonstrated by experience that the industry can solve its difficulties in a way that promotes the welfare and security of the nation. It has likewise been shown by all human history that Government cannot find the answer to all of the manifold troubles of individual and economic groups. The one method has always resulted in greater productivity, greater prosperity and a strengthened moral fiber. The other way—the totalitarian way—has always ended in misery and ruin and chaos.

It is bad enough to turn our backs upon the lesson of experience and sail forth into uncharted seas. It is inviting national suicide to venture into waters that are charted by the wrecks of all who have ventured therein. The oil industry is determined to follow the historic pattern of free competition that has made our country strong and great. It will fight to the last against those who would destroy or mutilate that pattern.

This job of preserving the industry's historic freedom is not one that can safely be left to the proverbial George. It is the individual responsibility of every American citizen, and it rests with added weight upon those identified with the oil industry. It is your job—and mine—and upon how well we meet this great obligation of citizenship may well depend the destiny of America and the world.

We may as well realize that halfway measures will not suffice. We cannot afford to temporize or compromise. There is too much at stake—the fate of our country—for us to sell the day to serve the hour. We must be forthright and militant. We must gird ourselves for all-out warfare in behalf of sacred principles, because this is no child's play. This is, I repeat, a battle for survival.

Destiny chose for our thrilling American adventure, a land of inexhaustible riches. But those riches would have lain useless, as in other richly endowed land masses, had it not been for the American spirit. It is not the gold in the hills but the iron in the hearts of the American people that has told the story.

I hope we may go forth from this meeting with the high resolve that whatever the cost, the oil industry will fight to the end to retain its freedom. Against such determined purpose and against the industry's record of unparalleled achievement, the advocates of strange and destructive philosophies cannot stand. If we remain true to our convictions, we will win this battle and go forward to higher peaks of accomplishment. If we falter, if we lack in courage, then we shall not deserve to win.

We must not hesitate. We must not compromise. We will march forward together, armed with the mighty weapon of truth and fact, and we shall win.

* * *

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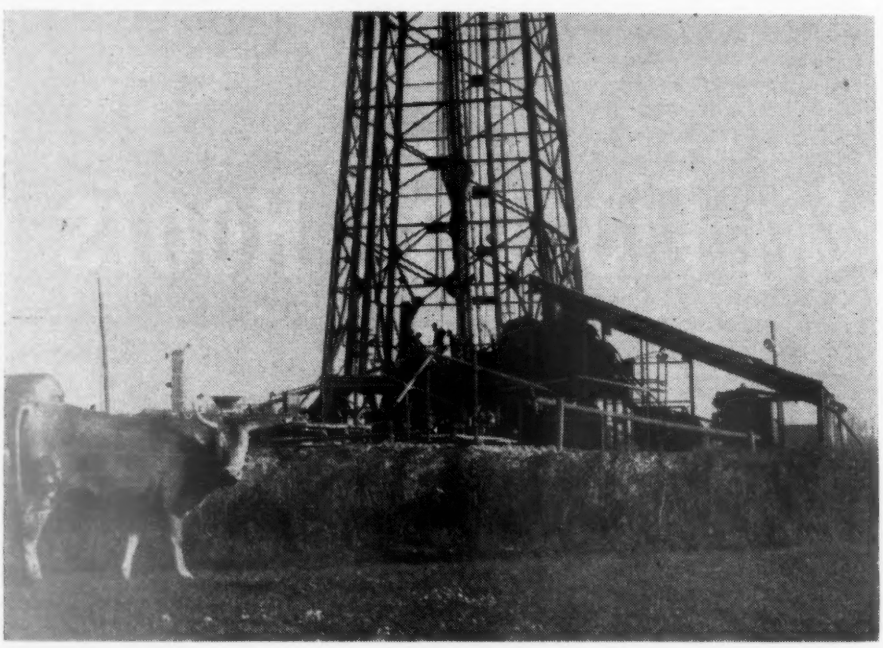
Discovery well, Lacq No. 1, is now on pump.

New Oil Field Discovered in France

Societe Nationale des Petroles D'Aquitaine Brings In What Appears to Be a Major Oil Field in South France



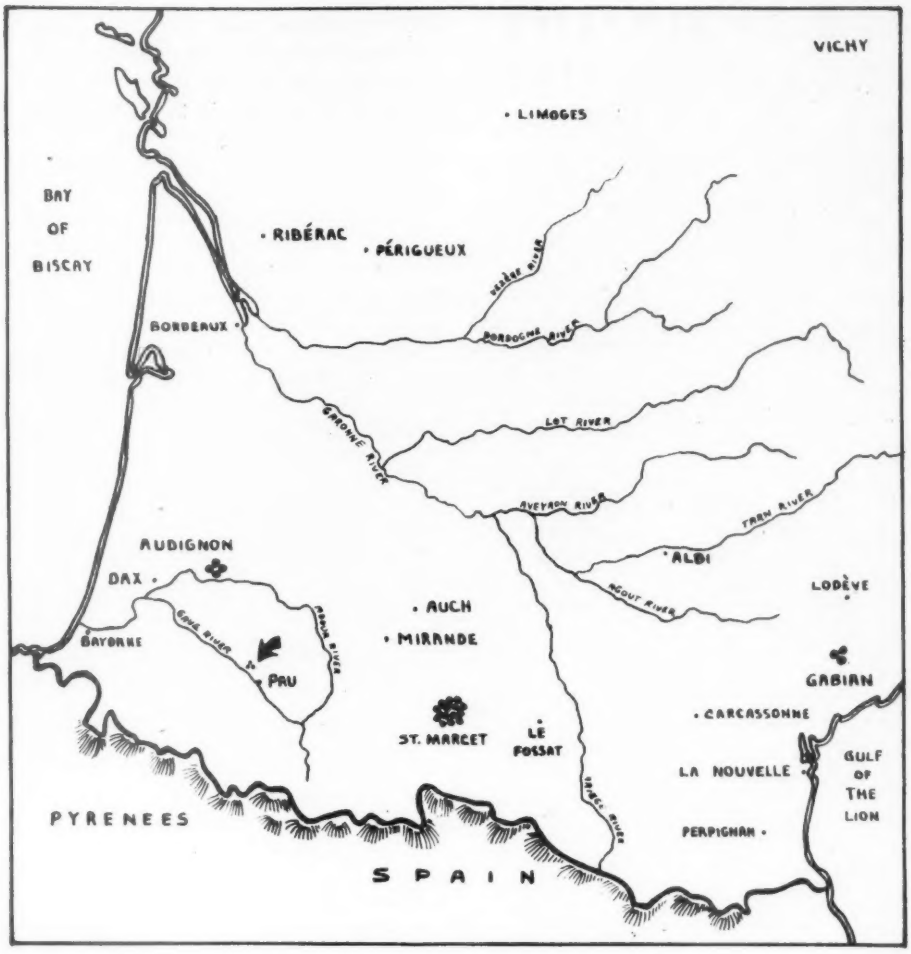
Rig was skidded to second location, Lacq No. 2, and a big producer brought in. French cow mugs camera.

EXCLUSIVE

A NEW oil field has been discovered in France some 15 miles northwest of Pau near the Pyrenees mountains (see map). It is situated in a flat valley bottom and bordered less than 50 miles south by medium height mountains and some 15 miles north by small hills. The surrounding country is comparatively flat for some 50 miles in length and 20 miles in width.

Geology and Geophysic

The surface beds are Pleistocene with no surface indication of a structure. Reflexion seismic work has out-



Arrow points to new field near Pau where two wells are completed and one nearing completion. Other dots show producing wells in old fields. Map does not cover the location of the largest French field, Pechelbronn, in northeast France. Total oil production from French fields now runs about 34,000 bbl a month.

lined an anticline with its axis following the general direction of the valley, which is northwest-southeast. The contours have a good closure on the northeast flank. Total amount of closure is 900 feet. They are less defined on the southwest flank probably because of the presence of several faults.

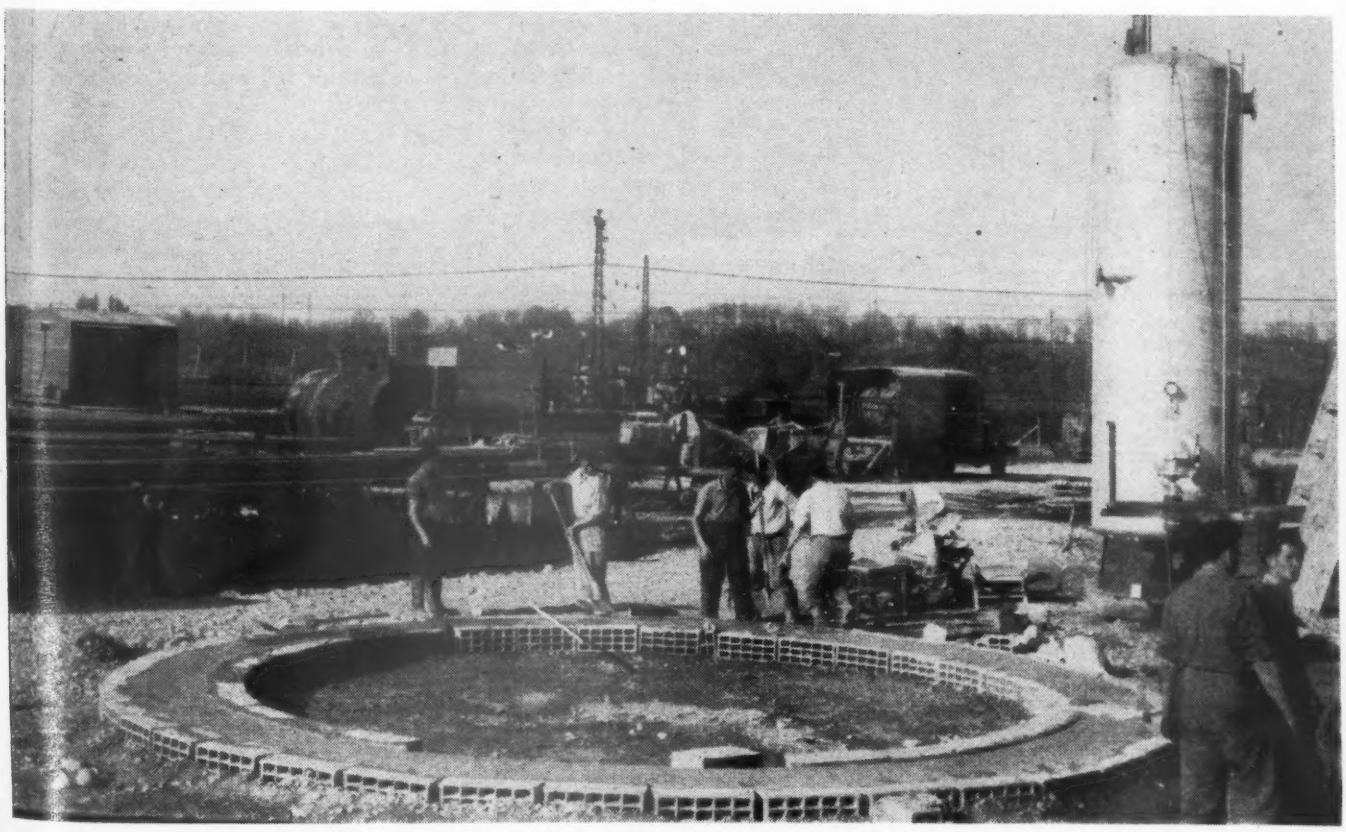
Field sizes on seismic picture are 8 miles in length and 5 miles wide.

A main highway and railroad run close to the main axis of the field. The railroad station of Lacq, a small village on the field, is a quarter of a mile only from the discovery well Lacq No. 1.

Discovery Well

Lacq No. 1 was drilled in November, 1949 by Societe Nationale des Petroles D'Aquitaine and reached a depth of

At Lacq No. 2a tank is being erected for storage. The No. 2 well was much larger producer than discovery well, making 700 bbl a day on 5/16-in. choke.



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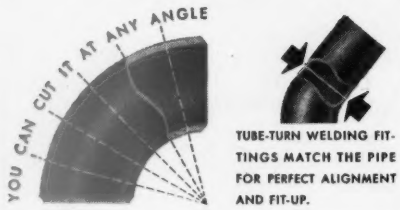

TUBE-TURN WELDING FITTINGS MATCH THE PIPE FOR PERFECT ALIGNMENT AND FIT-UP.

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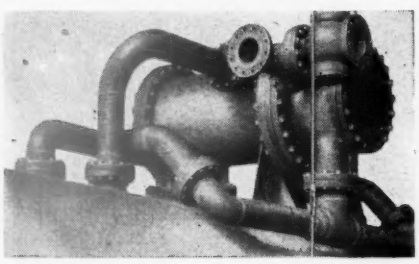

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2289 ft where some saturated limestone and dolomite were encountered. It was intended as a deep test and after setting a 16-in. casing at 1900 ft was drilling a 12½-in. hole reduced to 8½-in. when it reached the saturated section.

Casing was set at 1923 ft and cemented. It flowed around 20 bbl per day. It was then placed on the pump and produced during March at the rate of 70 bbl per day with some water. Production was increased during March up to 140 bbl with 15 per cent water. It has been established since that the water comes from a leaky water shutoff.

Outstanding Producer

The derrick of No. 1 was skidded some 1700 ft across the flat prairie and drilling resumed at the end of January at a spot northeast of No. 1 along the railroad, practically at the seismic top of the structure. After a serious loss of time in a fishing job a 12-in. hole was drilled down to 2060 ft by March 7, when a heavy loss of mud occurred and lowered the mud level, causing a small blowout. Casing was set at 2040 ft with about 20 ft open hole below. A wooden plug was lowered and a cement plug placed above it. Casing was then cemented under low pressure. In order to protect the upper Miocene sands two more cement jobs were run by stage through perforations.

On April 22 the well was put on production and various chokes tried. On a 1½-in. choke it gave 9000 bbl a day, and on a $\frac{5}{16}$-in. choke it gave 700 bbl a day.

It is being produced at that rate since, with a bottom pressure of 966 psi and a wellhead pressure of 84 lb.

The oil is quite heavy, being 0.920 density and will not yield much gasoline but is all right for fuel oil and lubricating oil.

Drilling Program

Two more locations have been made 1700 ft southwest of Lacq No. 1 and No. 2 and are drilling now with two light rigs. A third heavier rig will start a deep well soon.

Geological Column

Pleistocene-Miocene: 800 ft of sand and shale.

Eocene: 880 ft all shale.

Cretaceous: Only 560 ft have been drilled so far. The top part is calcareous marls and shows on unconformity followed by the producing section, which is porous limestone and dolomite.

This is the big oil discovery of France so far. * * *

Cannon Asks FTC Funds for Oil Investigation

Another study of the economic concentration of the oil industry was proposed recently by Representative Cannon (Democrat, Missouri).

Cannon, who is chairman of the House Appropriations Committee, appeared before a House Commerce subcommittee that is holding hearings on oil industry problems. He testified in behalf of his resolution asking $250,000 for the Federal Trade Commission for such an inquiry. He said the FTC lacked funds to make the broad study he envisaged, since it now had only $80,000 with which to make economic studies of all American industries.

The investigation would include production, refining, transportation, distribution, and imports of petroleum, and would center on four main points:

1. Whether there is a monopoly of crude oil production facilities.
2. Whether the Interstate Oil Compact, designed to permit the states to get together on conservation policies, has also been used to control prices to the consumer.
3. Whether depletion allowances to the oil industry are excessive, as charged by President Truman.
4. What effect on the domestic oil market is caused by the ownership of foreign oil wells by American companies and their imports into the U. S.

Representative Heselton (Republican, Massachusetts,) asked why the Appropriations Committee had not given the FTC the funds necessary to make the oil study. Cannon said the FTC had never requested the funds and that his committee would be happy to consider such a request if it were made.

Also testifying in support of Congressman Cannon's resolution were A. D. Sappington, general counsel of the Missouri Farmers' Association; Robert Freer, former FTC chairman who appeared on behalf of the National Congress of Petroleum Retailers; and Benton J. Strong, of the National Farmers' Union. A statement was read from Albert Goss, master of the National Grange, in support of the investigation.

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U. S. Oil Stocks and the Import Problem

S. A. SWENSRUD

The President of Gulf Oil Corporation Presents, Before the Texas Railroad Commission, His Company's Views on What Stocks Are Needed for Efficient Operations and the Most Satisfactory Level of Imports.

OUR company's views with regard to the safe United States minimum stock levels for the industry as a whole for crude oil, gasoline, and heating oils, are set forth below the figures which in our judgment constitute such minimum stock levels for the various products involved, as of April 1 and September 1. These figures are on the basis reported regularly to the United States Bureau of Mines.

	April 1	September 1
Crude	245,000,000 bbl	245,000,000 bbl
Gasoline	130,000,000 bbl	100,000,000 bbl
Middle distillates (kerosine, diesel and light heating oils	50,000,000 bbl	100,000,000 bbl
Residual fuel	40,000,000 bbl	55,000,000 bbl
Total	465,000,000 bbl	500,000,000 bbl

The crude stocks on hand on April 1 of this year were about at the level shown above and were we believe adequate for working requirements at the 1950 level of the industry's operations. We see no reason for any difference in the minimum crude oil stock figure for April 1 and September 1. We do not undertake to say that the figure shown above is the exact requirement but we think that it is about in the proper range. There are so many grades of crude oil and short-term variations in refinery runs of different companies and other factors that vary that we could never expect the actual stocks to be as low as some theoretical figure that might be worked out on the assumption that every company had just the right working stock of every grade of crude oil. We can say, however, experience has indicated that when the total stocks get below a certain level, approximately in the range we have indicated, difficulties of operating satisfactorily begin to appear. For example, at the beginning of 1948 total crude oil stocks were about 230,000,000 bbl and at this level many operating problems were encountered. On the other hand experience has indicated that under present levels of operation when stocks get as high as they were last summer, which was in excess of 270,000,000 bbl, they tend to be burdensome, leaving insufficient room in storage tanks and lack of flexibility generally.

The figures we have indicated for each of the major product groups are arrived at in much the same manner. The April 1 figure of 130,000,000 bbl of gasoline is lower than the actual figure of about 135,000,000 bbl that was on hand at April 1 of this year. The rapid seasonal decline in gasoline stocks that sets in when gasoline consumption begins to increase with warm weather makes it clear that the industry must have a substantial quantity of gasoline accumulated at the beginning of the heavy consuming season if it is going to meet the requirements of the motoring public. The experience of many years indicates that about September 30 rather than September 1 marks the end of the high gasoline consuming season and the time when gasoline stocks can safely be at the lowest point. The stocks at the beginning of September must, therefore, be a little higher than at the end of September and the figure shown above of 100,000,000 bbl is on the basis of being a little above the minimum which we feel is satisfactory for the lowest point a month or so later.

On the so-called middle distillates, including light heating oil, kerosine, diesel oils, etc., we have shown a minimum stock or April 1 of 50,000,000 bbl. This is about in line with the total of these stocks on April 1 of this year which we believe represented about as low a figure as is desirable in view of the increase in consumption of these oils in the last few years. It is almost down to the level reached early in 1948 following the previous winter of short supply during which stocks were drawn down about as far as possible. October is usually the time when the heavy winter consumption of heating oils commences and when in consequence these stocks begin to decline. At that time, i.e., around the end of October, we believe it will be essential to have on hand about 110,000,000 bbl of these fuels, assuming normal winter weather ahead; and in order to reach this point by that time, it would, we believe, be essential to have approximately 100,000,000 bbl accumulated by September 1.

The figure we have shown for residual fuel represents about 30 days' supply on April 1 and about 35 days' supply on September 1.

Imports

Early this year, in January, our company publicly announced its intention of reducing its imports of crude oil by approximately 12,000 bbl daily from the daily average of the last quarter of 1949. The level of the last quarter was approximately 117,000 bbl daily. Since the end of January, therefore, our program has been to hold our imports down to an average of approximately 105,000 bbl daily, and since the end of January we have done this. The figures for any given month will of course be above or below this average figure because of the irregularity of tanker arrivals, but from the end of January to the latest date in May for which the figures were available our average imports were just slightly under 105,000 bbl daily, and on the basis of our expected receipts for the whole of May the same will be true for the period to the end of May. We are not importing any petroleum products.

As for the last half of the year, we see no reason to expect any material change one way or the other in the level of our crude oil imports during the balance of the year.

In view of the current interest in the subject of petroleum imports, we believe it may be appropriate for us to comment briefly upon our company's position in this matter.

While by far the greater part of our company's business and investments are in the United States, we have crude oil production in Venezuela, the Middle East, and in Canada. Gulf has pioneered in finding and developing oil abroad just as it has been a pioneer in production in the United States and particularly in Texas where our company began with the discovery of the Spindletop Field

just about 50 years ago. Most of the oil we produce abroad is sold abroad, but some of it is brought to the United States.

We believe that it is important to our national welfare and national security for American companies to have ownership interests in crude oil reserves in other areas of the world where oil is plentiful.

We do not need to look back very far to recall the time less than two years ago when there was an acute shortage of petroleum products in this country. At that time our company was being implored by government agencies and many refining companies to do everything it could to bring in additional foreign crude oil products to meet the shortage situation. From many sources we were not only encouraged but urged to take steps to help protect against future shortages by increasing production, refining, and transportation facilities. Our company not only redoubled its efforts to add to its crude production in this country but took various measures to augment its supplies from abroad. We committed ourselves to a substantial enlargement of our Philadelphia refinery; and to protect this with an assured source of supply, we arranged for large ships to be built to bring additional oil from the Middle East. Our company has always relied to a considerable extent on Venezuela crude for its Philadelphia refinery requirements, but even though Middle East crude was more expensive, including transportation, we felt that the prudent thing to do was to prepare ourselves for bringing in a certain amount of the more distant crude. As these plans matured in 1949, the result was to increase our total imports of crude oil to some extent. By that time, however, it had developed that the industry had achieved more production capacity in this country than had been expected a year or two earlier; moreover total demand instead of increasing, as usual, declined slightly in 1949, and therefore much apprehension appeared regarding the increase in the rate of imports.

Our company has been sensitive to these factors, and it has no desire to increase its imports to any point which would be damaging to our domestic industry. As already indicated, our principal investment is in this country, and we ourselves have suffered severely in the proration cutback. Last year, for example, even though we drilled over 700 new productive wells our net crude oil production in the United States was approximately 39,000 bbl daily below the previous year. In view of the domestic supply and demand situation, we announced in January of this year our intention of reducing our imports to a point 12,000 bbl daily below the level of the last quarter of 1949. That was a reduction of over 10 per cent.

I do not think I can express our company's policy better than Colonel Drake, Chairman of our Board, did in making the announcement of our decision to reduce our imports. In his statement, he said:

"In drawing up operating plans, our company is governed by many considerations among which the interest of the consumer has a most important place. We do not feel that we can forecast any element of our supply with complete accuracy. Accordingly, we are guided by the principle of flexibility, so that our schedules can be altered if unforeseen conditions arise as they often do. It is necessary for our company, like all others, to balance our supply and demand, and, therefore, we cannot overproduce or overimport without incurring economic penalties. While I cannot attempt to lay out a long time specific import program for our company because we shall be guided by changing conditions, I can say we are convinced that our imports should be flexible, show some conformance to seasonal variations in demand, and be influenced by the expected volume of increase or decrease in total consumption."

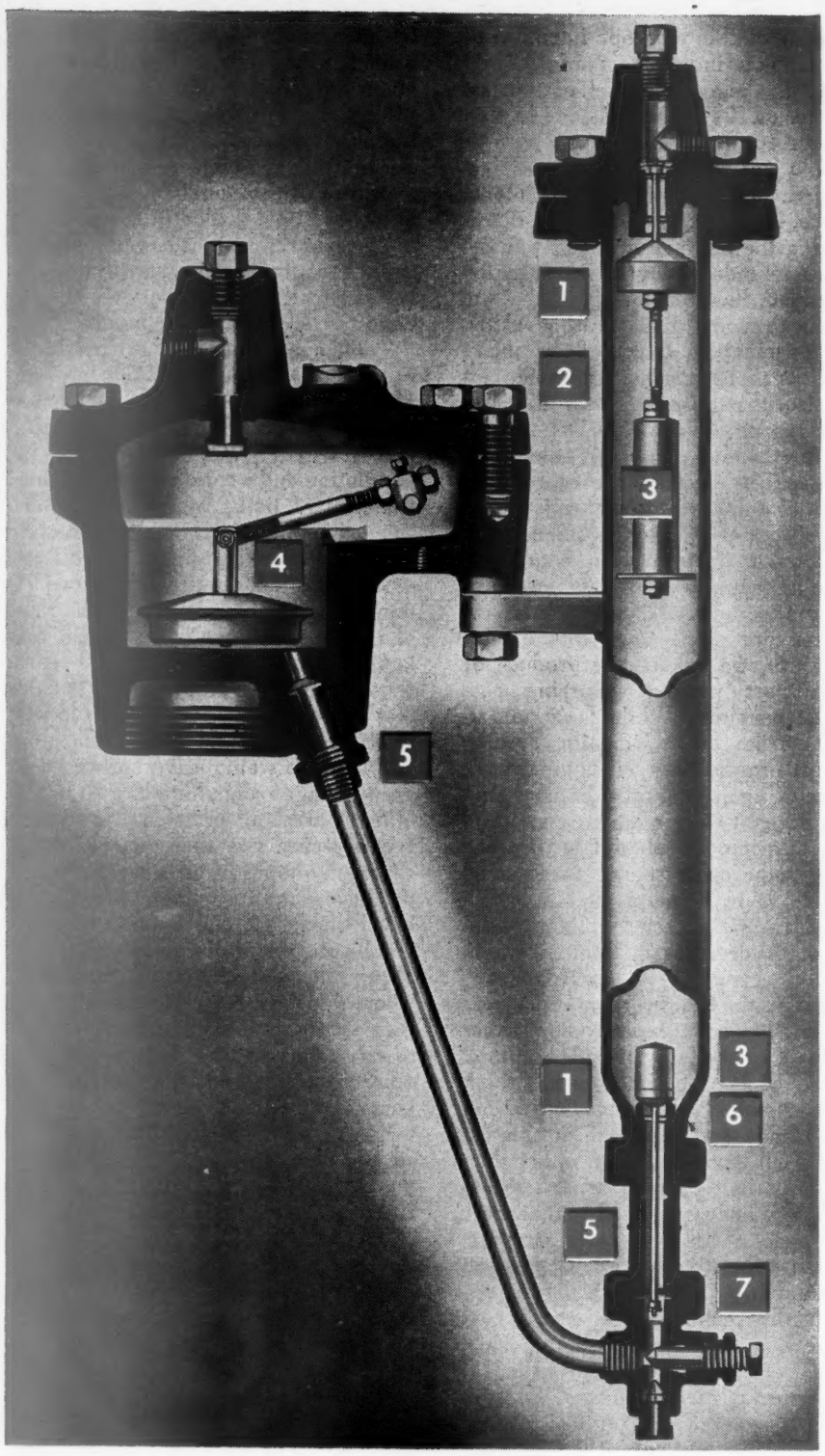
During the last several months there appears to have been some further increase in the level of total imports, i.e., of crude oil and products. I think I have made it clear that Gulf is not responsible for any part of this increase—it having reduced rather than increased its total imports. What does appear to have happened is that there has been a bulge in total imports caused primarily by an increase in residual fuel imports, which was undoubtedly related to the recent coal strike and to the colder-than-normal spring weather that has prevailed in a large part of the country. Fuel oil imports appear, for example, to have represented about half of the total imports for March. The industry figures for recent months, however, indicate that crude oil imports have stabilized at a level lower than the last quarter of 1949, and it would appear to us that with warmer weather fuel oil imports should show a decline. We feel therefore that it would not be correct to draw the conclusion from the figures for recent months that imports are still on the upgrade.

Before concluding this brief statement of our position, I would like to emphasize again the long range factors, which it seems to me are involved in this question of imports. Our country uses about ⅔ of all the oil consumed in the world and yet it has only about ⅓ of the proven reserves, and I am afraid it has a much smaller percentage than that of the potential reserves when we consider how many hundreds of thousands of exploratory wells have been drilled in this country in the search for oil as compared with the rest of the world where the number of exploratory wells drilled can almost be counted in the hundreds.

Total consumption of oil products in this country has increased by over 50 per cent in the last 10 years from around 4,000,000 bbl to almost 6,500,000 bbl daily. With the increase in population and a constantly advancing standard of living, omitting all consideration of national defense, it seems reasonable to suppose that our oil requirements will continue to grow. If they grow at only about half the rate of increase we have witnessed in the last 10 years, then by another 10 years we will be using 8,500,000 to 9,000,000 bbl daily of petroleum products in this country, and during the next 10 years we would have consumed a grand total of something like 26 or 28 billion barrels of petroleum products. I can assure you that our company shares the hopes of all other crude oil producers in this country for great new discoveries, and I am sure there will be many new discoveries; but our requirements are enormous and somewhere down the road—we hope a long way—it seems to us that we will need to rely to a greater extent on oil from other parts of the world, where it appears to be more plentiful, relative to local needs, if we are to continue to supply the consumers in this country at reasonable prices with the quantities of petroleum products they desire.

To me, therefore, the question is not one of imports versus domestic production—it is a question of having both available and at all times attempting to preserve a reasonable and flexible balance between the two which will produce the best over-all result for all concerned. It was in that spirit that our company last January announced its intention of reducing its imports, with which undertaking it has scrupulously complied.

In short, it seems to me that oil imports in general have reversed the sharply rising trend of last fall, as a result of the operation of normal economic forces. With over-all demand for oil on the upgrade, it may be anticipated with considerable confidence that the so-called import problem is undergoing a natural solution. Interfering with this solution by government action would in my opinion, weaken, not strengthen, the oil economy.



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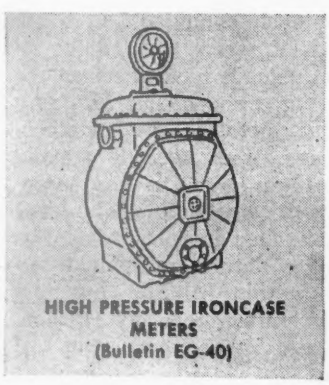
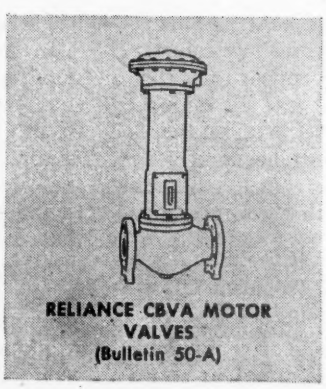
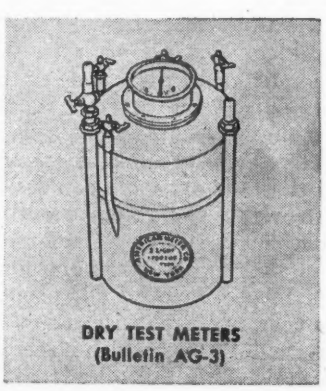
5. **Union Type Connections for Interchangeability of Range Tubes**
6. **Swaged Hi-Side Tube**
7. **New Pulsation Dampener**



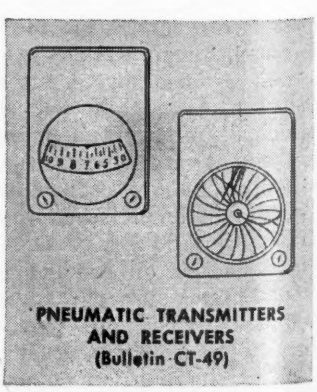
HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)



RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)



DRY TEST METERS
(Bulletin AG-3)



PNEUMATIC TRANSMITTERS AND RECEIVERS
(Bulletin CT-49)

Bottom-Hole Vs Reservoir Pressure

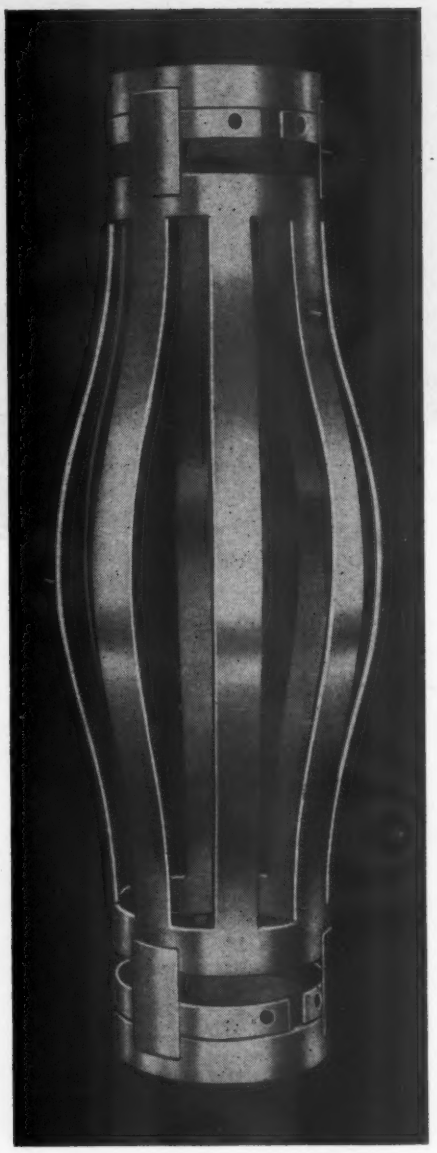
AN ARTICLE beginning on page B-7 of this issue of *The Petroleum Engineer* presents a simple method for determining whether or not a well is producing as much oil as reservoir conditions indicate it should from a study of the bottom-hole pressure "build-up" curve. Such curves often show that certain wells are not completed effectively, that is, they are not connected adequately to the surrounding reservoir rock. As a result of a poor connection, the rate of flow into a "damaged" well is not as great as it might be were the flow channels immediately around the bottom of the well increased in size or number.

It does not surprise experienced operators to find that the production of many wells can be increased considerably by acid or chemical treatment; drilling a little deeper; perforating a larger section of the casing or liner in the producing formation; increasing the density of perforations by reperforating the same section; reaming or cleaning the sand-face; washing the openings in liners or the perforations in the casing; or performing other remedial work to open the well more effectively to the producing formation. The big questions in the minds of most operators, including experienced ones, are: (1) How much improvement may be obtained in the productivity of the well by certain remedial work or by treatment of the producing formation around the well, and (2) How long will the increased production hold up? Application of the method described in the article should aid considerably in predicting the answers to these questions.

Few producing formations are permeable enough to build up the bottom-hole pressure in a well to the reservoir pressure in less than a 24-hr period. Many producing formations are so impermeable that the bottom-hole pressure in a well would not equalize but would continue to build up for many days or even weeks after the well was shut in. Studies of these build-up curves and the differences that may exist between bottom-hole pressures and reservoir pressure should guide operators in deciding whether or not it might pay to use remedial measures. A knowledge of the build-up curve characteristics in various parts of a reservoir also may enable operators to reduce key-well shut-in time on periodic pressure surveys, thus reducing the cost of such surveys.

K Marshall Faginn

Here are the Facts about CENTERING CASING



Only through the effective centering of your casing in the open hole can you obtain a sufficiently uniform annular cementing space to permit distribution of the cement slurry completely around the casing. Under this condition the hazard of channeling is minimized, and the best opportunity for success of the installation is present.

When you run a Baker Model "G" Casing Centralizer you can rest assured that it will do a proper centering job. You need no longer worry about trial-and-error centering of your casing, because the Baker Centralizer is a proven centralizer with many exclusive as well as desirable features:

1. It exerts maximum centering force where it is needed—not as the centralizer first enters the well bore, or above the first well constriction, but after the most rugged trip to the bottom of the hole, at the point where the actual centering job must be done.

2. Its springs are designed on the basis of maximum spring centralizing efficiency alone, without any interference from complicating factors.

3. Its springs are *never* forced to deflect over the sharp edge of a ring or collar, since they are *butt-welded* (not lap-welded or riveted) to the Spring Collars; and the Stop Rings are positioned safely *outside* of the spring assembly area. Thus the casing supports the total centering force by direct contact with the springs.

4. As its springs deflect, their active length decreases. They are thereby stiffened and their centralizing action is increased.

5. All of its springs are compressed simultaneously as a unit and cannot be deflected individually.

6. Its mounting design permits rotation of the casing even under adverse conditions, and within annular clearances smaller than can be approached by any other centralizer.

7. It is, in effect, scientifically "tailor-made" to produce optimum characteristics for each individual casing range.

8. It starts easily, and the Baker "tailor-made" feature eliminates the need for snubbing.

9. It is easy to install on the pipe. No on-the-job sizing or adjusting is required. Everything is pre-positioned so that the unit may be merely slipped on the casing and welded in place.

10. It is always PULLED (never pushed) as it is run-in the hole. This averts the danger of distorting or otherwise damaging the springs while raising or lowering the casing string past restrictions in the hole.

All of these features contribute to the fact that the Baker Model "G" Casing Centralizer yields greater centering force than any other spring-type casing centralizer within desired annular clearance ranges over the entire area to be cemented.

COMPARISON IS INTERESTING

You will find it both interesting and instructive to fill in the CHECK CHART on the opposite page, which brings out the important facts about "centralizing."

Application of Build-Up Curves to Determine Reservoir Pressures and Permeabilities

C. C. MILLER, A. B. DYES, C. A. HUTCHINSON, JR.

A simple method of using bottom-hole pressure data to indicate well "damage" and to predict the possibilities of improving the productivity by treatment or recompletion.

THE estimation of the effective permeability and of reservoir pressure in the drainage area of a well has long been a problem for the petroleum engineer. Direct analysis of the cores taken from the well supplemented by productivity index data will not permit determination of the actual permeability of the formation because of conditions in and around the well bore at the time of coring or testing, and because of differences between laboratory and field conditions. The rate of pressure build-up in a shut-in well, which is affected by the permeability of the producing formation, may be used, however, for a direct evaluation of the in situ effective permeability based on the actual performance of the reservoir.

In the estimation of reservoir pressure it is a familiar practice to shut in a well and, after a fixed period of time, record a bottom hole pressure measurement. This is then taken to represent the actual reservoir pressure. Only in fields of very high permeability, however, will the equilibrium reservoir pressure be recorded. It is, therefore, inadequate to measure the reservoir pressure in this manner in the majority of cases. Several methods have been designed for the estimation of reservoir pressure using build-up characteristics of the well. Muskat[1] presented a method involving a semi-logarithmic plot of the build-up, and Arps and Smith[2] used a rectilinear plot of the rate of build-up. These methods are based upon the assumption of an incompressible fluid flowing from the reservoir into an open flow string, increasing the back pressure on the formation. A more fundamental approach to the problem has been presented by Muskat,[3] considering a compressible fluid in a radial flow system with the pressure at the external boundary maintained constant. This represents a case with maximum migration over the external boundary. The authors have given further consideration to this approach and have also investigated a similar system but with zero migration over the external boundary.[7]

This paper presents a simple method for obtaining effective permeability and reservoir pressure from the build-up curve. Also, it shows that the build-up and productivity tests furnish complementary information for evaluating the degree of any damage or improvement to the permeability in the area of the reservoir immediately surrounding the well bore.

Permeability Estimation

When the build-up data on a well are plotted as pressure against log time, there will be a section of the curve that is almost straight that may be used for permeability estimation. (This is independent of the degree of migration over the external boundary.) In a formation of uniform permeability with the flow shut off at the sandface, as assumed in Muskat's development, the straight line section will encompass the mid 80 per cent of the rise in pressure. Except in pumping wells, however, the well is shut in at the surface, allowing some flow into the well bore after shut-in due to the compressibility of the fluids in the bore. It is also likely that the permeability in the immediate vicinity of the well is different from that in the majority of the drainage area. These two factors cause the useful straight line section of the build-up curve (p vs log t) to be shorter and possibly to be completely absent, though this latter situation has not been encountered by the authors. The effective permeability, k_2, may be shown as a function of the slope, m, of the straight line section of the p vs log t build-up curve. This permeability is the effective permeability to oil in the drainage area excluding the immediate vicinity of the well. The equation for calculating permeability is

$$k_2 = \frac{162.5\, q\mu F}{mh} \quad . \quad . \quad . \quad (1)$$

where k_2 = effective permeability to oil in the majority of the drainage area, in millidarcys,

EXCLUSIVE

THE AUTHORS

Charles C. Miller

Alvin B. Dyes

C. A. Hutchinson, Jr.

Charles C. Miller was recently advanced to the position of principal reservoir engineer in the Research and Development Department of the Atlantic Refining Company in Dallas, Texas. A native of New Orleans, he received his B E degree from Tulane University and a M S degree in chemical engineering from the University of Michigan. He joined the Atlantic Refining Company in 1941.

Alvin B. Dyes is the associate reservoir engineer in Atlantic Refining Company's Research and Development Department. Born in Georgia, he received the B S degree in chemical engineering from Georgia Tech in a cooperative educational program with the Hercules Powder Company. He joined the Atlantic Refining Company in 1945.

Charles A. Hutchinson, Jr., is also assistant reservoir engineer with Atlantic in the Research and Development Department. He joined Atlantic in January, 1949. A native of Colorado, he obtained a B S degree in electrical engineering and a B S and a M S in chemical engineering from University of Colorado.

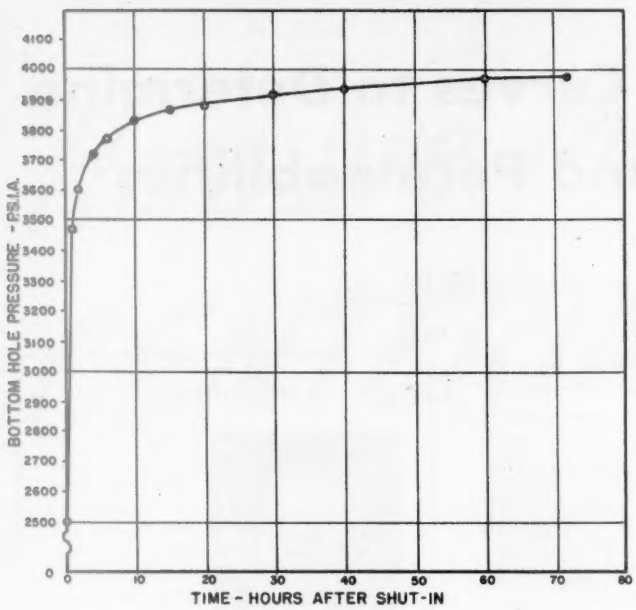


FIG. 1. Conventional build-up plot (p vs t)
Data used in sample calculation

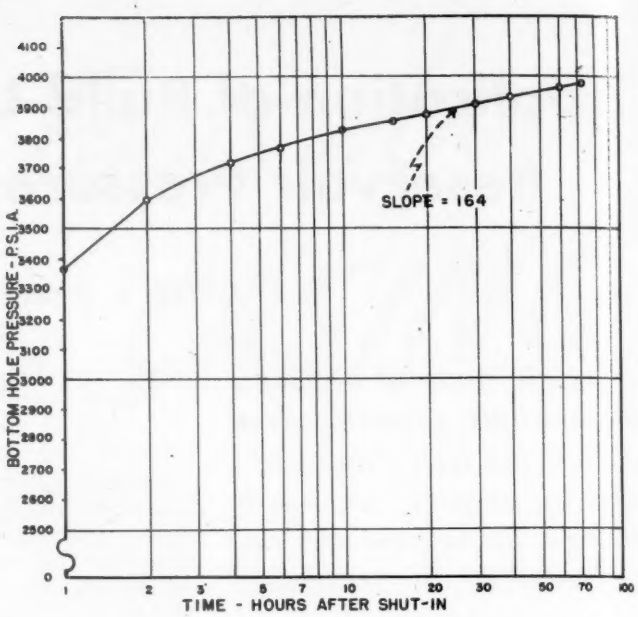


FIG. 2. Semilogarithmic build-up plot (p vs log t)
Data used in sample calculation

m = slope of the straight line section of the p versus log t build-up curve, psi.,
q = oil production rate prior to shut-in, in stock tank barrels per day,
μ = oil viscosity, centipoises,
F = formation volume factor, reservoir barrels per stock tank barrel, and
h = net effective pay thickness, ft.

In examining the pressure-log time build-up curve it may be difficult to ascertain the proper slope to use in equation (1) as several straight line sections may appear present. Thus, it is necessary to provide a check to see that the proper section was used. The general build-up equations[2] when plotted on semilogarithmic basis exhibit a straight line up to a definite break occurring in the range of $T = 10^{-1}$ where T is a dimensionless variable proportional to time defined by the equation

$$T = \frac{0.0002637\, k_2 t}{f\, \beta\, \mu r_e^2} \left(\frac{\gamma_o + \gamma_g R}{F\, \gamma_T} \right) \quad \ldots\ldots\ldots\ldots (2)$$

where t = time, hours after shut-in
k_2 = effective permeability to oil, millidarcys,
f = formation porosity, fraction,
β = mean fluid compressibility, psi^{-1},
r_e = radius of drainage, ft,
γ_o = density of stock tank oil, lb/stock tank barrel
γ_g = density of gas, lb/std cu ft
γ_T = mean density of reservoir fluids, lb/reservoir barrel
R = gas-oil ratio, std cu ft per stock tank barrel, and.
F = formation volume factor, reservoir barrels per stock tank barrel.

Studies of the effects of flow into the well after shut-in and of varied permeability in the immediate vicinity of the well indicate that the practical lower limit of the straight line is in the range of $T = 5 \times 10^{-3}$. Thus, equation (2) may be used as a check equation. The time corresponding to the end of the straight-line section of the build-up curve, whose slope is used in equation (1), and the permeability as obtained from equation (1) are used in equation (2) along with an assumed radius of drainage. The T calculated should then fall in the region of 10^{-2} to 10^{-1} to constitute a check. If a straight line section is selected improperly, that is too early in the build-up curve, and with too great a slope, which results from flow into the well bore after shut-in, the time as well as the permeability determined will be too low. This results in a value of T that is well below the cited range. A value of T well above the cited range may be obtained, if a section too late in the build-up is used. The radius of drainage may be approximated from well spacing and production characteristics of the wells in the region. With an unsaturated oil in the reservoir, the quantity in parentheses on equation (2) is unity. In the experience of the authors, this quantity has been unity for all practical purposes for the cases when both oil and gas are flowing.

A limitation in the use of equation (1) is that the well must be stabilized prior to shut-in by constant production over a period of time. Sometimes a considerable period is required for stabilization of the well to essentially steady state conditions prior to shut-in. The necessary steady state, however, is sufficiently approximated in many cases to make the equations applicable. In the case of a well definitely unstabilized at the time of shut-in the analysis breaks down. The authors have found in such instances that the electrical analyzer[4] provides very satisfactory answers concerning the build-up characteristics and this method should be employed in such instances. The analysis also breaks down when the well is in a gas cap region. Equation (1) is rigorously applicable for the flow of a homogeneous compressible liquid in the reservoir and gives a good approximation when both oil and gas are flowing.

In order to illustrate the method of procedure the following calculation is made for a typical well producing from a tight formation.

Shut-in Time (hours)	Bottom Hole Pressure (psi)
0	2500
1	3470
2	3600
4	3713
6	3769
10	3826
15	3861
20	3882
30	3911
40	3932
60	3961
72	3975

These data are shown plotted in the conventional manner in Fig. 1 (p vs t) and as a semilogarithmic plot in Fig. 2 (p vs log t). The other data necessary for calculations are

$F = 1.70$ (reservoir barrels per stock tank barrel)
$\mu = 0.30$ centipoises
$h = 125$ ft
$r_e = 1000$ ft
$f = 0.15$
$C_w = 0.20$
$C_o = 0.80$
$\beta_w = 3.2\text{x}10^{-6}$ psi^{-1}
$\beta_o = 1.55\text{x}10^{-5}$ psi^{-1}
$q = 250$ STB/day

The compressibility of the system is

$$\beta = C_o\beta_o + C_w\beta_w = (0.8)(1.55\text{x}10^{-5}) + (0.2)(3.20\text{x}10^{-6}) = 1.30\text{x}10^{-5} \text{ psi}^{-1}.$$

In the plot of Fig. 2 there are two possible straight lines whose slopes could be used in equation (1). It is generally better to try the upper line first if two straight lines appear. The slope of the upper line is

$$m = \frac{3975\text{-}3882}{\log\frac{72}{20}} = 164$$

Equation (1) then gives

$$k_2 = \frac{(162.5)(250)(0.30)(1.70)}{(164)(125)} = 1.01 \text{ md.}$$

This is the effective permeability of the formation provided the proper straight line was used. A check is made by equation (2).

$$T = \frac{(0.0002637)(1.01)(72)}{(0.15)(1.30\text{x}10^{-5})(0.30)(1000)^2} = 3.28\text{x}10^{-2}$$

This value falls in the range of 10^{-2} to 10^{-1} and constitutes a check. If the earlier straight line section of the curve were used the values calculated would have been: $k = 0.42$ md, and $T = 9.5\text{x}10^{-4}$ which, of course, is out of the check range.

Reservoir Pressure

A number of authors[1,2,3,4,5,6] have examined build-up characteristics to obtain methods for reservoir pressure estimation. The present paper presents a more fundamental approach to the problem in which a compressible fluid is flowing in the reservoir with the well shut-in at the surface. The effects of flow into the well bore after shut-in and/or an increase or decrease in the permeability around the well are also considered. The method presented here requires a shorter shut-in time than is general in previously reported approaches.

The straight line section of the build-up curve that was used for estimation of effective permeability is in direct correspondence with a similar straight line in a semilogarithmic plot of the build-up equations.[7] In this straight line section the build-up equations plot coincidentally for no migration over the radius of drainage and for maximum migration over the radius of drainage. Thus, the actual build-up curve may be matched with the build-up equations and reservoir pressure calculated. The equation for this calculation is

$$P_e = P_x - m \log (10T_x) + 0.625\ m\frac{q_e}{q_w} \quad . \quad . \quad . \quad . \quad (3)$$

where:

P_e = reservoir pressure, psi,
P_x = pressure point at end of straight line of p vs log t plot, psi,
m = slope of straight line of p vs log t plot,
T_x = dimensionless variable (equation 2) at $t = t_x$ corresponding to P_x, and
q_e/q_w = relative degree of migration over the external boundary, influx rate/production rate, fraction.

If the radius of drainage used to calculate T is obtained from well spacing, a value for the relative degree of migration over the external boundary, q_e/q_w, must be estimated for equation (3) by considering the producing characteristics of the well and of the offset wells.

At this point it is interesting to note the errors that enter this equation. The variables that may be in error are the individual pressure measurements in the build-up curve, production rate prior to shut in, net effective pay thickness, compressibility, formation volume factor, porosity, migration over the radius of drainage, and radius of drainage. These last two factors may actually be grouped into a single error factor.

A statistical analysis of the manner these errors effect the pressure estimation indicate that in a very tight formation ($k = 0.5$ millidarcys) the additional rise in pressure to an equilibrium value from the last measured point in a reasonable shut-in time is in the order of several hundred psi and the error in reservoir pressure is about ± 20 psi. In a relatively loose formation ($k = 50$ millidarcys) when less rise is expected after the last measured point, the error is considerably less. Now the sample calculation performed for permeability estimation may be continued to determine the reservoir pressure as

$$P_e = P_x - m \log (10T_x) + 0.652m\ q_e/q_w = 3975 - 164(-0.484) = 4055 \text{ psi.}$$

if q_e/q_w is taken as zero. (Closed boundary)

Steady State Conditions

The preceding equations have all been derived for a system with a steady state pressure distribution prior to shut in of the well. This distribution is obtained by flowing the well at a constant production rate for a period of time. A graphical method[9] for the transient solution of the diffusivity equation provides a means for the determination of time. In a finite time, of course, steady state will not actually be obtained, but it will be approximated sufficiently for all practical purposes. The time required to approach steady state conditions is a function of the radius of drainage, permeability and porosity of the formation, and compressibility and viscosity of the fluid. It is independent of the rate of production and the net thickness of pay. This time is given as

$$t_s = 50\frac{f\beta\mu r_e^2}{k_2} \quad . \quad . \quad . \quad (4)$$

where t_s is the time in days required to approximate a steady state. Thus, if the approximate order of magnitude of the permeability is known, a pressure survey may be planned using equation (4). The constant 50 of equation (4) was determined for an initially uniform pressure distribution and represents the maximum period to be expected. In such instances where the well has been produced for some time and it is desired to stabilize at a new production rate, the time for the attainment of steady state at the new production rate will be less.

Shut In Time

Because it is undesirable to shut in a well over a long period of time, it is necessary in planning a pressure survey to estimate in advance the length of shut-in time required to obtain a sufficient section of the build-up curve for the determination of permeability and reservoir pressure. An expression for this time required may be taken directly from equation (2). The upper limit of the straight line section of the build-up curve plotted as pressure versus logarithmic time should be approximately $T = 5 \text{ x } 10^{-2}$. Substituting this value in equation (2) and solving for t, we have

$$t_{si} = 190 \frac{f\beta\mu r_e^2}{k_2} \quad . \quad . \quad . \quad (5)$$

where t_{si} is the time required in shut in hours. Once again, knowledge of the approximate order of magnitude of the permeability will enable the engineer to estimate more accurately the length of time that is required to shut in a well.

Well Damage and Improvement Studies

The permeability as estimated by equation (1) from the slope of the build-up curve represents the effective permeability of the drainage area away from the well. The permeability as estimated from the productivity index using the steady state radial flow equation represents the average effective permeability of the entire drainage area. If these two permeabilities are different, there will be a section in the immediate vicinity of the well with a permeability different from that of the majority of the area drained. The ratio of the productivity index permeability to the build-up permeability is a measure of the degree of difference. The ratio of the permeability from the productivity index and the steady state radial flow equation to the permeability from the build-up curve is equivalent to the ratio of the actual productive capacity of the well to the productive capacity of the well that would exist, if the permeability in the immediate vicinity of the well were the same as that in the majority of the drainage area.

If the permeability determined from the slope of the build-up curve is greater than the permeability that would be determined from the productivity index there is an indication of damage or a low permeability area in the immediate vicinity of the well. Likewise, if the productivity index permeability is greater than the permeability as determined from the slope of the build-up curve, there will be an area of higher permeability around the well. This will enable the reservoir engineer to determine the presence of a damaged or improved permeability region at the sandface.

Likewise, the analysis may be used to obtain an estimate of the improvement in productive capacity that may be anticipated from treatment of the well and to show the improvement resulting. When an arbitrary radius of the extent of the low or high permeability area around the well is taken, the equation relating the various permeability values is

$$\frac{k}{k_2} = \frac{\log \frac{r_e}{r_w}}{\frac{k_2}{k_1} \log \frac{r_1}{r_w} + \log \frac{r_e}{r_1}} \quad . \quad (6)$$

where r_1 is the radial extent of the permeability in the immediate vicinity of the well,

k_1 is the permeability in the immediate vicinity of the well,

k_2 is the permeability away from the well estimated from the build-up curve, and

k is the average permeability from the productivity index.

The equation for estimating this "damage" ratio is

$$\frac{k}{k_2} = \frac{2(\text{P.I.})\ m \log \frac{r_e}{r_w}}{q} \quad . \quad (7)$$

where "P.I." is the productivity index, bbl oil per day per psi, of the well. Employing equation (7) and the data from the sample calculation

$$\frac{k}{k_2} = \frac{(2)\left(\frac{250}{4055\text{-}2500}\right)(164)(3.602}{250}$$

$$= 0.76$$

This is a damaged well and is producing only 76 per cent of what it would have been producing were no damage (or section of low permeability) present. If it is assumed that the damaged area extends to 5 ft from the well, the permeability around the well may be determined by equation (6) as 0.54 md. As a further comparison assume that the permeability in this damaged area may be increased ten fold to 5.4 md by some means such as acidization. If such were the case, k/k_2 would be 1.42 and the well, originally producing 250 bbl oil per day, would produce 468 bbl oil per day with the same drawdown. This is an 87 per cent increase over the present production.

The authors have used the methods presented in this paper in the analyses of over 100 build-up curves, including a range of permeability from 0.2 to 200 md, reservoir pressures from 500 to 6000 psi, and conditions of highly unsaturated oil to conditions of both oil and gas flowing in the reservoir. The methods have also been used effectively in planning pressure surveys and in the evaluation of well productivity and the expected productivity from treatment.

Nomenclature

Symbol	Quantity	Units
f	porosity	fraction
F	formation volume factor	rvb/STB (reservoir bbl per stock tank bbl)
h	net effective pay thickness	ft
k	permeability	md. (millidarcies)
m	slope of build-up curve	psi (lb per sq in.)
p	Pressure	psi
q	oil production rate	STB/day (stock tank bbl per day)
q_e/q_w	relative migration at external boundary	fraction
r	radius from center of well	ft
R	gas oil ratio	SCF/STB (std cu ft per stock tank bbl)
t	time	hours, days
T	dimensionless variable proportional to time	
μ	viscosity	cp (centipoises)
β	compressibility	psi^{-1}
Υ	density	lb/SCF, lb/bbl

Subscripts

1	area around well
2	area away from well
e	external boundary, equilibrium
g	gas
o	oil
s	stabilize
si	shut-in
T	total system
w	well
x	designated point

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Water Flooding in the Humboldt-Chanute Oil Field, Neosho and Allen Counties, Kansas

JOHN C. JOERS,[1] PETER GRANDONE,[2] D. B. TALIAFERRO[3]

THE Humboldt-Chanute field is in the southeast corner of Allen County and the northeast corner of Neosho County, Kansas, and, according to Sweeney,[4] contains 15,500 productive acres. The field includes about 65 per cent of the oil-productive area of the two counties.

The field became an important oil-producing area in 1901. Drilling was at first confined to the valley of the Neosho River but in 1903 was rapidly extended in all directions. The northern limit of the field is about 3 miles north of Humboldt and the southern limit about 4 miles south of Chanute. The field ranges in width from 3 to 7 miles, the western edge bordering on the city limits of Chanute. The principal producing horizon is the Bartlesville sand, which is found at depths of 800 to 900 ft. The initial production of most wells in the field was small, but they were fairly "long-lived producers."

The production history of the Humboldt-Chanute field has been similar to that of most of the shallow fields of eastern Kansas. When vacuum came into general use about 1915 to 1917, it was widely applied in the field. In 1925 to 1935, many compressor plants were built for the injection of air and gas. Production from Allen and Neosho Counties exceeds 33,000,000 bbl of oil, and two-thirds of this probably has been from the Humboldt-Chanute field.

The first water-flooding operation in the field was started in 1937. This report describes the initial project, which set a new record for average daily production in 1949 and is still in operation, and two other major projects in the field. Also included is a description of a new pilot flood on which novel methods of operation are being used for the first time in the eastern Kansas shallow fields. In the discussion of the three major projects, information is given on the source and treatment of flood water, early production history of the properties flooded, the development of the flood, and the results obtained. Maps of each project are presented as well as curves showing graphically the production history of the flood.

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LYNDE, WALTER, DARBY FLOOD

The Lynde, Walter, and Darby water-flooding project just east of Chanute, in the eastern half of T27S-R18E, Neosho County, Kansas, is the oldest systematic water flood in the Humboldt - Chanute field. It was started on the Kaney and Ingraham leases late in 1937. The operation was limited to these leases until 1941, but in that year the development was extended to other leases and continued at a moderate rate until 1945, when the project included 266 acres. Since 1945, development has continued at an accelerated pace. More than 180 acres were developed during 1949 and the entire project included about 1020 acres on January 1, 1950. Fig. 1 shows the extent of the project.

Production is from the Bartlesville sand, the top of which ranges in depth from 715 ft in wells on the south end of the project to 765 ft in wells near the north end. These variations are the result largely of differences in surface elevation. Other production included in the flood is from a stray shoestring sand at a depth of 690 ft. This sand runs southeast and northwest across the main producing horizon at almost right angles to it. Core analyses show the Bartlesville sand to have an average porosity of about 20 per cent in this area. The average net thickness is between 25 and 30 ft. The permeability of the Bartlesville sand varies widely but averages about 50 millidarcys. The "stray" sand, running from the south edge of section 14 to the north edge of section 15, already mentioned (Fig. 1), is exceptionally permeable. Numerous core samples from this sand have been found to have permeabilities of more than 1200 millidarcys. The oil has an average gravity of 31 API. Numerous cores taken during the development for water flooding showed that the oil and water saturation of the sand varied widely from one part of the property to another and frequently from well to well.

[4]Sweeney, Albert E., Jr., Interstate Oil Compact Commission, Summary of Secondary Recovery Production Statistics and Estimated Water-Flood Reserves, Kansas, 1948: 62 pp.

Early History

Leases in the Lynde, Walter and Darby flood were included in the early development of the Humboldt - Chanute field, which started in 1898. The original development of these leases was completed by 1910. Although the decline in the rate of oil production from most wells in the field was gradual, many of the properties were abandoned before stimulative production methods came into use. Later, some of these leases were redeveloped, and it is reported that in some areas the water - flood development represents the third redrilling. Many of the old wells were improperly plugged, and they have been a constant and frequently a perplexing problem. As the location of most of the old abandoned holes is unknown, it usually is impossible to find them until water breaks out through them to the surface after pressure has been applied. Even then, it is often necessary to clear away several feet of earth with a bulldozer before the exact location can be found. In one area, 8 old wells were found within 300 ft of a new well.

About 1915, when the application of vacuum came into wide use in northeastern Oklahoma, vacuum plants were installed on the leases included in this project and were kept in operation for more than 20 years until water flooding was started in 1937. Air injection was not used extensively, but during 1929 and 1930 there were two or three air-injection wells on the Ingraham lease and the same number on the Kaney lease. Two wells were equipped for air injection on the Russel unit (see Fig. 1), but whether they were ever used for this purpose is not known.

As with most leases in the older Kansas fields, early production records are lacking. Neither the amount of oil recovered by primary production methods nor the effect of vacuum or air injection on the rate of oil production is known.

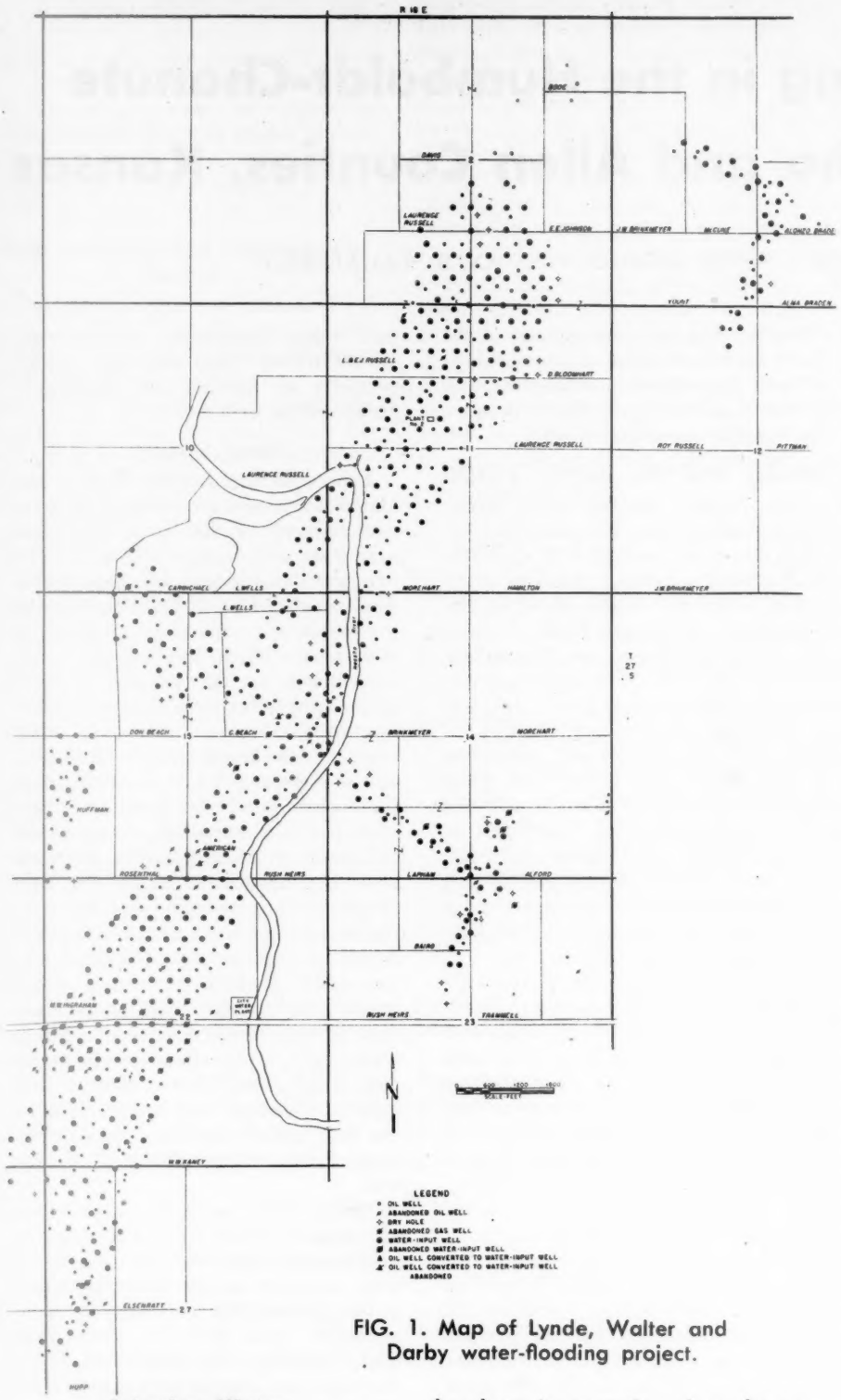

FIG. 1. Map of Lynde, Walter and Darby water-flooding project.

Injection Water

Fresh water from the Neosho River, which runs through the property, and brine produced with the oil are used for flooding. Two water plants—one at each end of the flood—having a total daily capacity of 22,500 bbl, feed water into a single system of lines to the water-injection wells at plant pressures of 800 psi. The size of the plants will permit some additional development. An average of about 20,000 bbl of water per day was injected during April 1950.

The No. 1 plant on the Kaney lease has been in operation since the project was started. Both the return water and the river water enter this plant through a wooden flume, 75-ft long, containing riffles. The necessary chemicals are added as the water enters the flume. During the first week of April, 1950, this plant handled 9000 bbl of water daily, to which 50 to 60 lb of hydrated lime, 200 lb of alum, 15 lb of liquid chlorine, 2 lb of ammonium sulfate, and 5 lb of copper sulfate were added. The water passes from the flume into an earthen pit equipped with earthen baffles to prevent channeling and to insure adequate reacting time. The water flows by gravity from the reaction pit into a concrete settling pit, from which it is picked up by a centrifugal pump and forced through 3 pressure-type sand filters connected in parallel, and thence into a 500-bbl clear-well tank. Finally, the water in the clear-well tank is pumped into the injection lines by three triplex pumps, each of which is driven by a 50-hp gas engine. Because of the low stage of the river in April, 1950, raw river water entering the plant had a pH of 8.3, but the water produced with the oil is slightly acid. The pH of the treated water ranged from 7.6 to 7.8. The retention time of water in this plant is about 3 days.

The No. 2 plant, on the Russell lease, was put into operation in October, 1945. The design and operation of this plant is similar to that of the No. 1 plant, but it has a slightly larger capacity and was handling 11,000 bbl of water daily during the first week of April, 1950. This plant is equipped with four pressure filters connected in parallel, two of which use a special filtering medium[5] and two use sand. Four triplex pumping units are employed, three of which are high-speed[6] pumps and one an older type[7] unit. The pumps are each powered with a 75-hp electric motor and a 60-hp motor drives the older pump.

Development of Flood

Most of the project has been developed on a fairly regular 5-spot pattern, although the pattern has not been maintained rigidly where the shoestring is very narrow or where unusual conditions of oil saturation make variations from the pattern desirable. The spacing between like wells is irregular, but usually like wells are 330 to 440 feet apart (Fig. 1). Most of the old wells were plugged, and the entire acreage was redrilled, although some of the old wells were retained and used temporarily. To the end of 1949, a total of 235 old wells had been plugged and abandoned.

Extensive coring was done in the development of the project, particularly since 1941. Both input and producing wells are shot. Where cores are available to serve as a guide, the wells are shot selectively with maximum charges of 5 qt of nitroglycerin per foot. Where fracturing of the sand is not necessary, a 1-in. shell is used to clean the sand face.

Originally, all of the producing wells were equipped to be pumped. However, during 1942 and 1943, the flowing of production from wells on

[5] Anthrafilt.
[6] Worthington.
[7] Aldrich.

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the Kaney lease was tried and found effective. Accordingly, from 1944 to 1946 all producing wells in the project were converted to flowing. All new wells completed since 1945 were equipped to flow from the beginning. The operator reports that individual lease records show a 30 to 40 per cent decrease in the rate of oil production immediately after conversion from pumping to flowing. However, after about a year, the production rate was back to the extrapolated pumping-production rate, and a year and a half later the lost production had been regained. In addition to the saving in lifting cost, flowing has eliminated all emulsion trouble. While the wells were being pumped, it was necessary to treat the oil, winter and summer. A greater ultimate recovery from the properties by flowing is indicated, because the reduced operating cost will result in a much longer economic life.

Initially, when the producing wells were pumped, they were equipped with casing, but no casing is used now in either the producing or injection wells. Two-inch cement-lined tubing is used in the producing wells to control corrosion, as the formation water is highly corrosive. By control of the pH of the injection water, the corrosiveness of the water is minimized, and cement-lined tubing is not used or needed in the injection wells. In both injection and producing wells the tubing is run with a rag packer, which is set by lowering it into the shot hole and then pulling it up against the top of the shot hole. A bucketful of crushed rock is placed on top of the packer, and the rock is followed by about 10 sacks of cement. The annulus between the tubing and the walls of the hole is filled with bentonitic mud from the top of the cement to the surface to prevent external corrosion of tubing.

All water-injection wells completed since the middle of 1949 are equipped with a ¾-in. wash string, which is run inside the tubing to about 2 ft from the bottom of the hole. It has been found that the sand face can be cleaned far more thoroughly by injecting water at a high velocity through this wash string than by depending on the back flow of the well. Each well so equipped is washed out daily during the first month of operation and occasionally thereafter. It is reported that the performance of wells equipped in this manner has been noticeably better than that of wells not equipped with wash strings.

The procedure for abandoning wells no longer useful in the operation of the flood is to set an eccentric packer in the 2-in. tubing opposite the cement plug and cover it with one sack of cement. After the cement has set, the tubing is shot off and pulled.

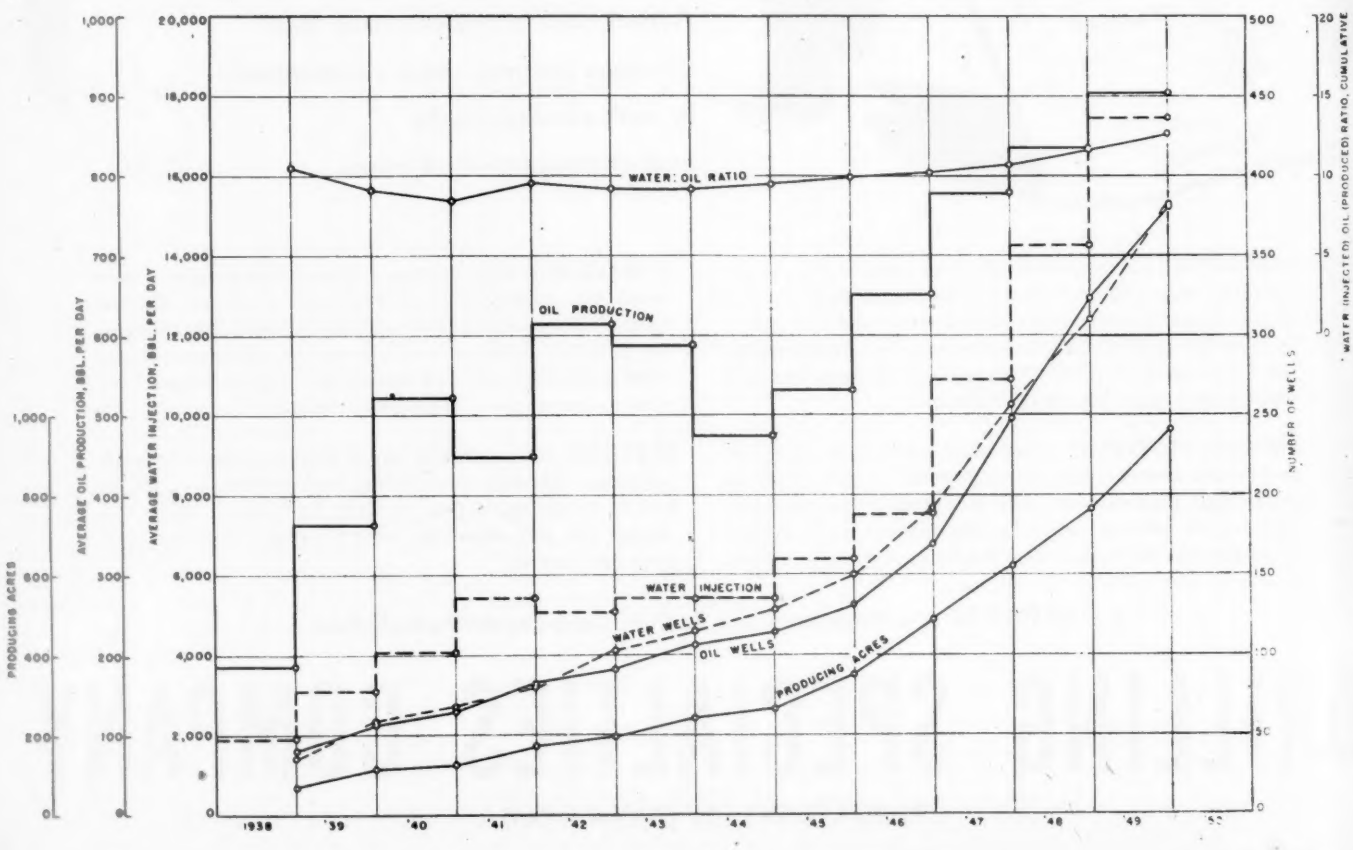
Result of Flooding

Fig. 2 shows graphically the average daily rate of oil production and the average daily rate of water injection for each year from the start of the project through 1949. The cumulative water:oil ratio, the number of active injection and producing wells, and the productiv area at the end of each year also are shown in this figure. It will be noted that at the end of 1949 there were 967 acres in the project on which there were 381 active oil wells and 382 active water-injection wells. There is a slight inaccuracy in the curves showing the number of active producing and injection wells, as before 1947 no record was kept of the number of old wells in use. For the period before 1947, these curves represent the number of new wells in service. The percentage of old wells in operation at any given time was small.

Because of the rapid rate of development during recent years, production from the flood has set a new record each year since 1944 for average daily production. The 1949 oil production totaled 330,495 bbl, or an average daily rate for the year of 905 bbl. During 1949, a total of 6,369,000 bbl of water was injected, or 19.3 bbl water for each barrel oil produced.

During the life of the flood to the end of 1949, a total of 2,519,000 bbl of oil had been recovered by water

FIG. 2. Production history of Lynde, Walter and Darby water-flooding project.



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flooding through the injection of 31,800,000 bbl of water. The cumulative water:oil ratio for the flood reached a record low of 8.5 in 1940 and has increased gradually since then to a ratio of 12.6 bbl of water injected for each barrel of oil produced to December 31, 1949. The oil recovery, expressed as barrels per acre, reached a peak of 4384 at the end of 1944 but since then has declined because of the rapid development of new acreage from which much oil is yet to be recovered.

Because of the continuing development of new flood acreage production, statistics on the flood as a whole give only a small indication of the success of the project. Although development of the flood started in 1937 and 1938, only two leases (Kaney and Ingraham) were included in the project until late in 1941. The flood on the Kaney lease was extended about threefold during 1946, 1947, and 1948. Development on the Ingraham lease was completed in 1941, however, and there has been no subsequent extension of the flood acreage on this lease except for the development of an additional 23 acres in 1948. By extrapolating the trend of the production curve for this lease before the new development in 1948, data may be obtained that indicate the final result of flooding the 102.4 acres covered by the original flood development. This extrapolation indicates that 591,200 bbl of oil was recovered from the original flood development on the Ingraham lease to the end of 1949 by the injection of 8,030,000 bbl of water. This represents the injection of only 13.6 bbl of water per barrel of oil produced and a recovery of 5,775 bbl of oil per acre. It is estimated that the ultimate oil recovery from this tract by water flooding will be about 6200 bbl per acre.

Although the high recovery per acre obtained on the Ingraham lease may not be maintained throughout the entire project, the performance of this lease suggests that there are many profitable years ahead for the project and that it will continue to yield an appreciable part of the oil produced in Neosho County.

KEAS DRILLING COMPANY FLOOD

The water-flooding project of the Keas Drilling Company in secs. 3, 4, 9, 10, and 15—T27S—R18E, Neosho County, includes the old Grant (W½, NW¼, sec. 15, now combined with Speilman) and the Rosenthal leases, which were developed first for flooding in 1939 and 1940 by Kirby Oil Company, and the Speilman (in sec. 3), Neyhard, Ames, and Nelson leases, which have been developed progressively since the end of 1946 by the present operator. The first two leases flooded were acquired by Grant-Mohan early in 1944, by Frank Young early in 1945, and by Keas Drilling Company late in 1946. Fig. 3 is a map of the properties showing the development to March 2, 1950.

The formation being flooded is the Bartlesville sandstone, which is found in this area at an average depth of about 700 ft and which has an average thickness of about 35 ft. Throughout most of the area the sand body, with a maximum thickness of 55 ft, is divided into two sections by a tight and relatively unproductive zone of sandy limestone. The lower section, with an average thickness of about 25 ft, is considered the more productive, although both sections are being flooded. The oil produced has a gravity of 32 API.

A summary of the analysis of a core from the Bartlesville sandstone taken from an input well on the Rosenthal lease is as follows:

Depth, feet	(upper section) 695.3–703.6	(lower section) 748.0–776.4
Average permeability, millidarcys	28	52
Average porosity, per cent	17.4	19.4
Average oil saturation, per cent	24.8	41.0
Average water saturation, per cent	66	43
Average oil content, barrels per acre-foot	335	618
Total oil content, barrels per acre	2,640	16,610

Early History

First drilling on the leases now being flooded started in 1903, and some have been redrilled as many as three times before water flooding. Oil was produced by pumping from the very beginning, but little is known about the amount of oil recovered by primary production methods. Air injection was the only stimulative method of production attempted, and this was applied on a very limited scale, using only two injection wells on the Neyhard lease in 1920. However, the project was soon discontinued, because results did not appear too favorable. The oil recovery before water flooding is not known.

Source of Water

Water for flooding the Grant and Rosenthal leases by the former operators was from the Neosho River, but since that time the principal source of water for the entire project has been six shallow fresh-water wells, completed in a gravel bed at a depth of about 40 ft. The water from the gravel bed is preferred to the river water because of the unvarying quantity and composition of salts in solution in the gravel bed water and because of its clearness. It does contain a fairly high content of dissolved iron, but the uniformity of the water permits the use of a regular treating procedure. The water from the gravel wells is pumped directly into the first of a series of five interconnected ponds. The open ponds provide enough aeration to oxidize the dissolved iron to the ferric state for precipitation before reaching the plant. All return water and occasionally river water needed to maintain the supply are pumped into the ponds for mixing with the shallow-well water. From the fifth pond the raw water is pumped into a 500-bbl treating and settling tank, where the necessary chemicals are added by an overhead mechanical feeder as it enters the top of the tank. The treated water then is pumped through a 6-ft pressure type filter filled with sand and gravel and finally into a 500-bbl clear water supply tank.

Treatment and pH of the water are controlled by a commercial laboratory. For a water throughput of about 3400 bbl daily (during April, 1950), 2 lb of copper sulfate were used daily as an algaecide. In general, the raw water requires a minimum of treatment and filtering, because it is relatively clear and chemically stable after oxidation and precipitation of dissolved iron in the ponds. The present retention time for water in the treating tank is only about 3½ hr. No unusual corrosive effects from the treated water have been observed, even though cement-lined pipe is not used. It has been necessary to acidize several input wells to remove carbonate scale from the sand face.

An injection pressure of 800 psi is maintained at the plant by means of three duplex, double-acting pumps each powered with a 50-hp diesel engine. Electric power is generated for all other power requirements by three diesel-driven generators, each of which is rated at 30 kw and 440 v.

Water-Flood Operation

In developing the Rosenthal and Grant (now part of Speilman) leases for water flooding, the first operator drilled the wells on a fairly regular rectangular 5-spot pattern with spacings between like wells of 330 ft in the east-west and 420 ft in the north-south direction. Development started in the fall of 1939, and by the end of 1940 a total of 63 acres with 26 water-input wells and 26 oil producing wells were completed on the two leases. No further development was carried out on adjoining leases until the property was acquired by Keas Drilling Company. This company leased a total of 1200 acres late in 1946. Its property includes the developed flood and acreage adjacent to it. By March, 1950, the company had extended the development to cover a total of 176 acres on which there are 90 active oil wells and 68 active input wells (Fig. 3). Development is still in progress. No definite

pattern or spacing was followed on the leases developed for flooding by the Keas Drilling Company. In general, spacing between like wells ranges from 300 to 400 ft. The operator does not determine the use to which each new well will be put until it has been drilled and the cuttings have been examined. No cores are taken. Most of the old stripper wells are utilized as producers without "work over."

All wells are completed alike for eventual flowing of the production on the new development. The wells are drilled through the entire sand section (2 sections in many wells), and 2-in. tubing is set on a packer 5 ft above the top of the sand and cemented with 24 sacks of cement. The packer used is the inexpensive rag type, which sets by pulling up on the tubing. No casing is used. Only the producing wells are shot, 3 qt of nitroglycerin being used per foot of sand, except for the top 5 ft, which are not shot. On the leases developed by the Kirby Oil Company, the producing wells were equipped with 6¼-in. casing to the top of the sand and with 2-in. tubing through which the wells were pumped. Input wells on the leases developed before 1946 were equipped with 2-in. tubing cemented at the top of the sand.

On the Rosenthal lease, however, three wells were dually completed in the two sand zones. A 1-in. string of tubing was set on a packer at the top (750 ft) of the lower sand section and cemented back to the bottom of the upper sand section. A 2-in. string of tubing concentric with the first string then was run and set on a packer and cemented at the top of the upper sand section. Water is injected at the same pressure into each sand section, but is metered separately. All wells on the Grant and Rosenthal leases were shot with nitroglycerin. One quart per foot of sand was used in the producing wells and 2 qt per foot of sand in the input wells.

All oil-producing wells completed since the Keas Drilling Company acquired the flood are equipped with small, individually powered electric pump jacks. An insert-type pump barrel is run on a 1-in. string of tubing. The tubing is attached to the pump jack, replacing the usual sucker rods and serving as the flow string. The pumps are kept running continuously at a rate high enough to keep the wells "pumped down" so long as the pump capacity permits. When a well starts to flow, the 1-in. tubing and pumping unit is moved to a new well. Wells on the old Grant lease were converted to flowing by the Keas Drilling Company, but most of the wells on the Rosenthal lease are still pumped. The central

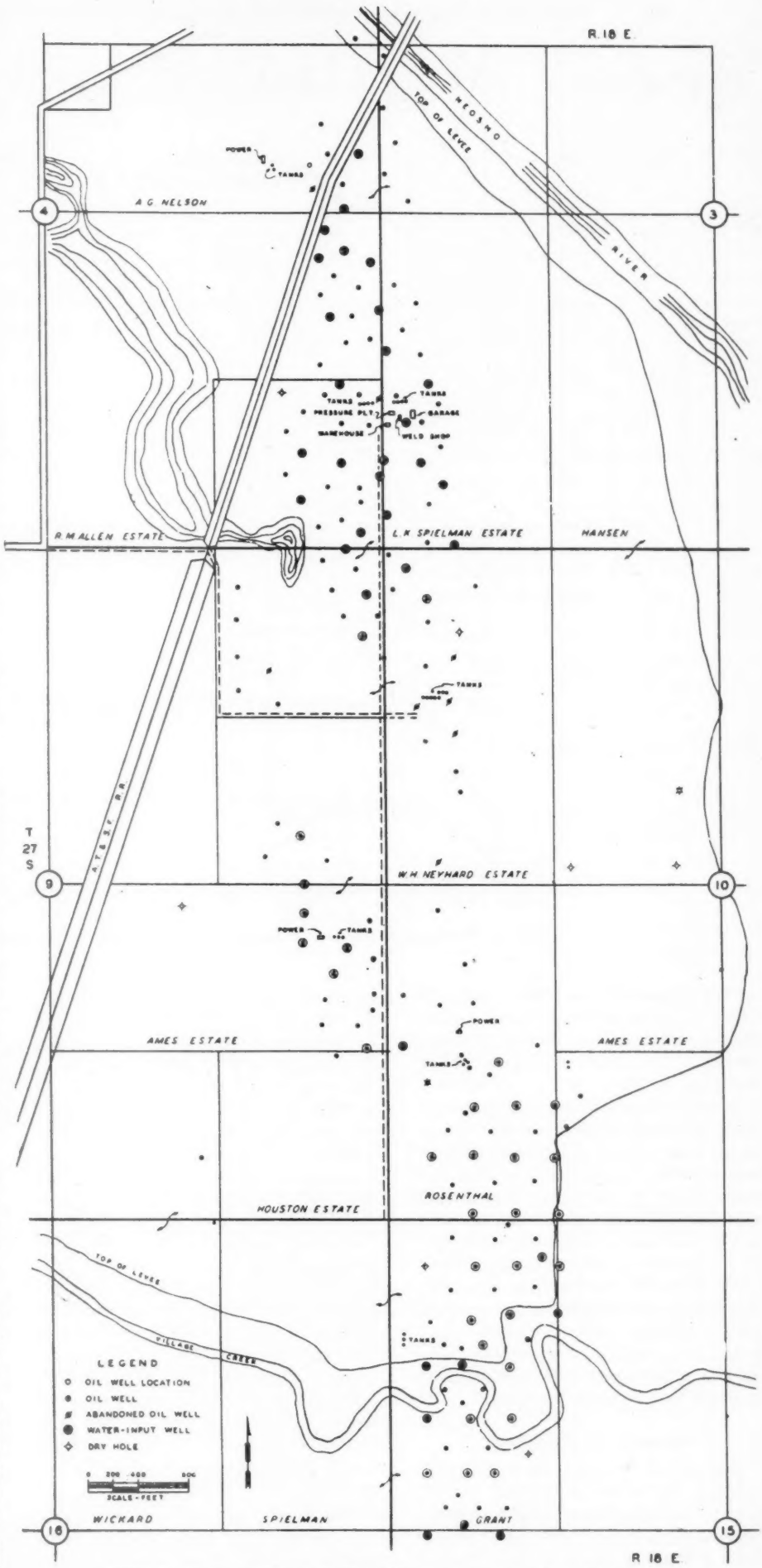

FIG. 3. Map of Keas Drilling Company water-flooding project.

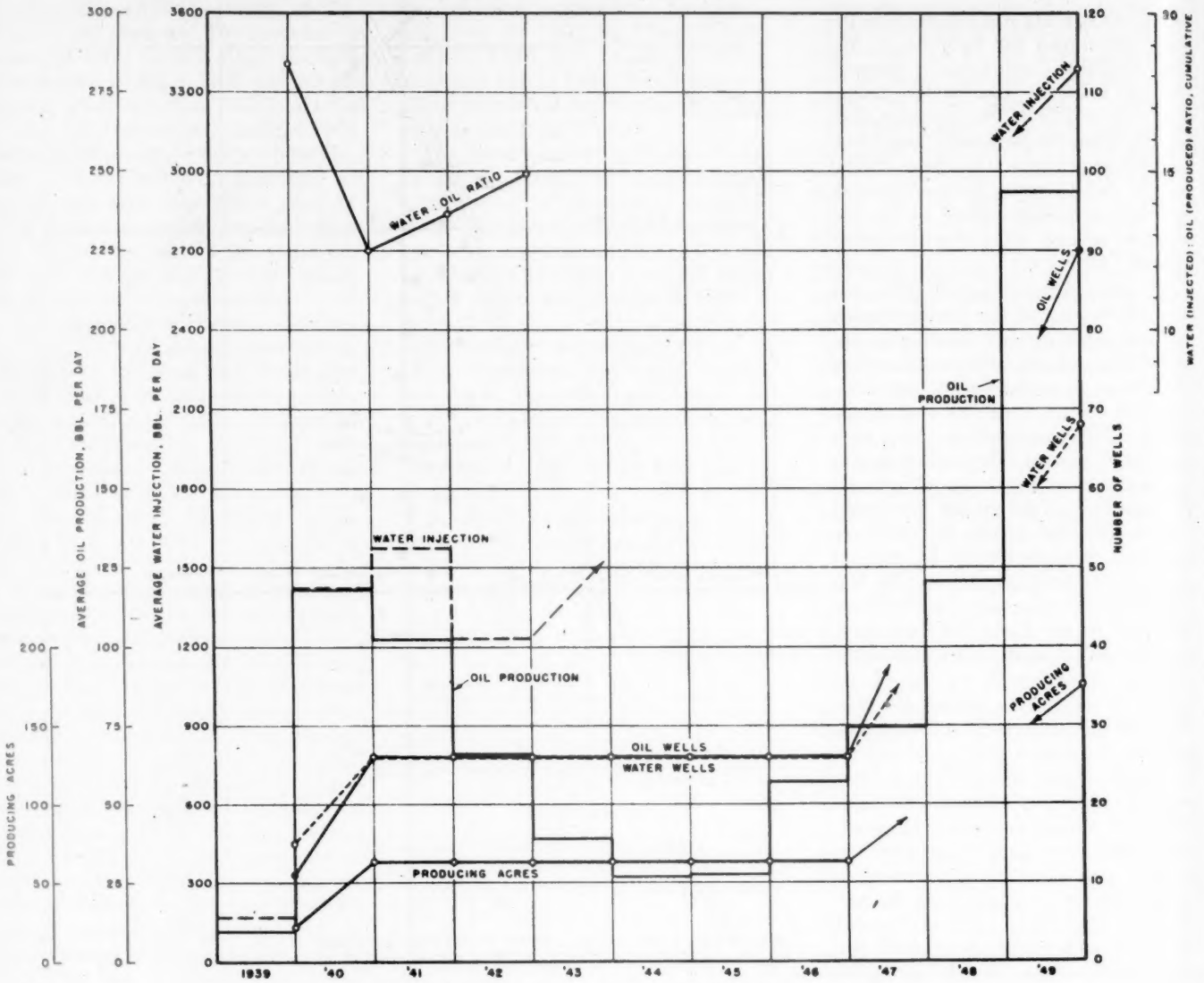

FIG. 4. Production history of Keas Drilling Company water-flooding project.

power originally installed and still used on this property does not permit the flexibility of operation obtained on other leases by the use of individual pumping units.

Meters installed on all injection wells are used to facilitate the adjustment and control of injection rates and recently to provide monthly records. Water is started into each well at a daily rate of about 3 bbl of water per foot of sand section until there is an increase in production of the offset wells. Then the rate is adjusted to keep the offset wells producing by continuous pumping. Only two wells have failed to produce continuously, and these are equipped with electric time controls for periodic pumping.

Results of Flooding

Results of flooding show that the original 63 acres developed on the Grant (now Speilman) and Rosenthal leases produced 162,690 bbl of oil, or 2586 bbl per acre, from 1939 to the end of 1946, when the property was acquired by Keas Drilling Company. At the end of 1949 there were 176 acres under flood (Fig. 3), from which the cumulative oil production by flooding was about 323,240 bbl—or an average recovery of 1837 bbl of oil per acre. This recovery is in no way indicative of the ultimate recovery to be obtained, because large parts of the area either still are at peak rates of production or have not yet been affected by water injection. No flood production has been obtained yet from the Nelson lease (see Fig. 3). It is impossible even to estimate the ultimate recovery from the leases developed in 1939 and 1940 from available data because of changes in operating methods and the fact that the production from one of these two leases has not been recorded separately since 1946 from that of other acreage developed more recently.

The Rosenthal lease, on which separate production records have been kept, produced 76 per cent as much oil in 1949 as it did in 1941—the year of its peak flood production. Fig. 4 shows graphically the production data on the flood that are available. The high rate of increase in the average daily oil production indicated during 1948 and 1949 will be continued during 1950, because of the rapid expansion of the project. The production during February, 1950 averaged 348 bbl of oil daily.

Little information is available on the quantity and rate of water injected during the entire operation of the project. Fig. 4 shows that the water-injection rate was about 1200 bbl daily at the end of 1942 on the 63 acres developed to that date, but this rate was increased to about 3400 bbl daily on 176 acres by April, 1950. The current ratio of injected water to oil produced on the entire project has no significance at this time, because large quantities of water are being injected on part of the acreage that has not had time to respond to the flood. * * *

Part 2 will be published soon.

Oil Producing Industry in Japan*

LEO W. STACH†

Increase in Petroleum Reserves Added During 1949 Puts New Life Into Occupied Country—Production Already Up in 1950

OPERATIONS in the Japanese petroleum industry in 1949-50 resulted in the first concrete gains after three years of effort by the producing industry to regain its former status, against very difficult economic and social circumstances. After thorough study of the situation during 1946, Natural Resources Section expressed the opinion that Japan's petroleum resources are by no means exhausted and that the revival of the industry is dependent on the finding of new reserves awaiting discovery. This year marks the first significant uptrend in production since 1934, a greatly improved reserve situation, increased efficiency in exploration methods and drilling techniques, and a strong revival of morale in the industry. Although Japan's producing industry supplies only about 10 per cent of the country's requirements of petroleum products, the expected future uptrend in production will make a significant contribution toward balancing Japan's economy by reducing future foreign exchange expenditures.

Production

Japan's crude oil production during 1949 averaged 3748 bbl daily, an increase of 22 per cent over the 3063 bbl daily average output of 1948. Production of 1,368,050 bbl of crude, including 15,240 bbl of natural gasoline, during 1949 was the highest annual production since 1945 and marks the first significant uptrend since the decline, which began in 1938; of this total, 94.5 per cent was produced by Imperial Oil Company.

During the year, 34 producers were completed out of a total of 63 wells drilled for a total footage of 149,066 ft. Total initial daily production from these producers was 1538 bbl and, for an average of 165 days production during 1949, these wells produced 144,710 bbl, equal to more than 10 per cent of the year's total production.

An analysis of the results of drilling shows that the percentage success rate for exploration drilling (outposts, 59 per cent; new pool tests, 33; new field wildcats, 0) compares favorably with that, for example, of California (53, 30, 5 per cent respectively).

Most of the new production was from extension and exploitation of deep reservoirs in Yabase field, Akita Prefecture, and exploitation of the Narahashi field, Yamagata Prefecture, which was discovered in 1947.

New Reserves Proved

Extensions were proved by test drilling in Hachimori field, Akita Prefecture; Narahashi field, Yamagata Prefecture; and Kaji field and the Betsuyama block of Nishiyama field, Niigata Prefecture; and a new shallow pool was discovered in Kaji field. These minor discoveries contributed about 250,000 bbl of new reserves.

The most significant discovery, however, was that of the deep zone VIII at about 4200 ft in Yabase field, Akita Prefecture, which was proved to extend south at least 12,500 ft from the extreme north end of the field where it was first found to be productive.

Present indications are that zone VIII is considerably thicker and has a larger productive area than zone VII; a preliminary estimate of the recoverable reserve of zone VIII is 6,290,000 bbl. Zones IX and X have been encountered in only one well to date, so that no estimate of reserves is yet possible. The electric log indicates, however, that zone IX may be more productive than zone VIII and that zone X is probably less significant.

Exploration Surveys

Exploration surveys for oil and natural gas continued at about the same scale of operations as in the previous three years, under the guidance of the Petroleum Resources Development Promotion Council. Some increase was made in surveys for methane gas, but some projects originally assigned to the Geological Survey and to academic institutions were cancelled because of the reduced exploration subsidy supplied by the Government.

Apart from the clarification of the detailed structure of several promising areas by geological and geophysical survey, the most significant results of the short-range exploration survey program were the following:

1. The northern part of a large structure immediately west of and parallel to Japan's largest oil field at Yabase was outlined in detail by seismic reflection and two culminations are indicated on the anticline; a test well location was selected for drilling early in 1950.
2. Shallow drilling through the volcanic detritus covering the area north of Narahashi field, Yamagata Prefecture revealed the possibility of additional fault trap accumulations similar to those of Ishinazaka and Narahashi fields; a test well location was selected in this area.

Geological surveys clarified details of structure and stratigraphy in Hokkaido; the deep test well on the Kawaguchi structure in northern Hokkaido, which is planned to test the Paleogene and Cretaceous, spudded in July and had penetrated 3500 ft of Miocene sediments by the year's end, after encountering trouble from high pressure water sands. Geophysical exploration was considerably accelerated by the use of two new portable seismic reflection units and two gravity meters, which arrived from the United States in July; one set of each was acquired by Imperial and the other sets by the Geological Survey. Gravity meters were used for the first time in Japan, all previous gravity work having been done either by pendulum survey or by torsion balance.

Research Programs

Paleontological research made considerable advances in 1949. Imperial Oil's micropaleontological staff was increased and a modern new laboratory was completed in October. The principal achievement of this laboratory was in detailed correlation of

*Released by Natural Resources Section personnel at the request of agencies in the United States for use in preparing annual reports on the world petroleum industry.

†Scientific Consultant, Mining and Geology Division, who prepared the report.

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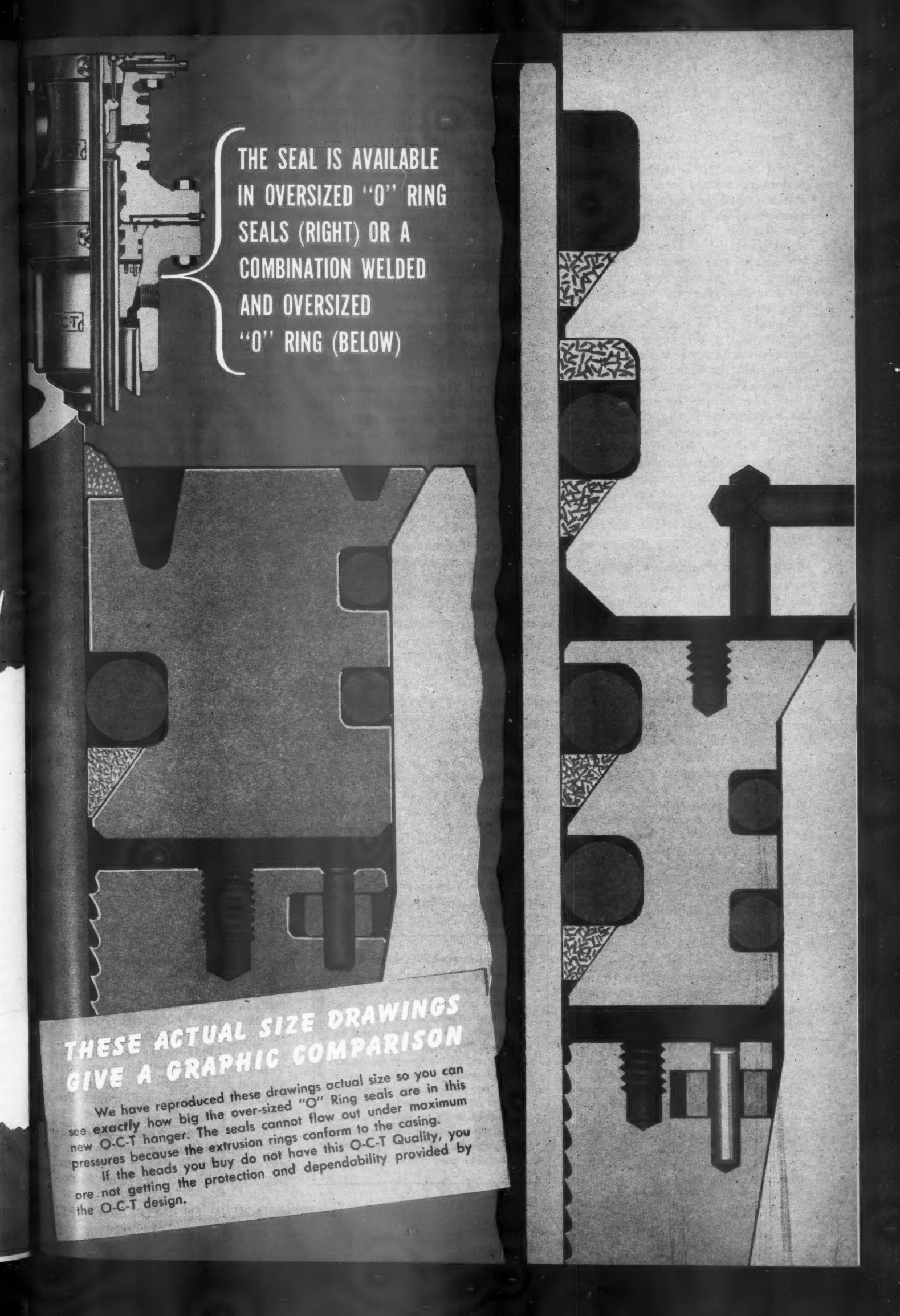
THE SEAL IS AVAILABLE IN OVERSIZED "O" RING SEALS (RIGHT) OR A COMBINATION WELDED AND OVERSIZED "O" RING (BELOW)
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wells in Kaji field, where the tracing of very thin lensing oilsands is a major problem.

Imperial Oil's chief paleontologist, Dr. T. Oinomikado, went to the United States in November to study modern laboratory techniques. Basic studies completed by academic institutions include a check list of Japanese Tertiary smaller Foraminifera and a check list of Japanese Tertiary Mollusca; a complete illustrated card catalogue of Japanese Tertiary smaller Foraminifera is being prepared for publication.

Footage drilled in 1949 was the highest during the Occupation and represents a 32 per cent increase over that of 1946, the highest previous year. The lower footages drilled in 1947 and 1948 were caused by the unsettled labor situation during that period. Much of the increase is due to improved efficiency of drilling operations by more careful control of the drilling fluid, reduction of cementing failures, and the introduction of new methods that reduce drilling time and enable the drilling of more wells in the same period.

Drilling and Production Methods

A notable increase was effected in the efficiency of drilling and production operations. Drilling times were reduced to a little more than half that of the previous few years by closer attention to mud control and more efficient cementing aided by two new skid-mounted cementing units imported from the United States. Several directional wells were satisfactorily completed in Yabase field, and gravel-packing was successfully applied for the first time in Japan at Narahashi field. Oil-base drilling muds were used for the first time in Japan to drill into the shallow low-pressure reservoirs in the Omonogawa area of Yabase field.

Preparations are being made for dual completion wells to exploit the new deep zones in Yabase field, and experiments are being conducted to determine the feasibility of secondary recovery by water-flooding in the shallow zone III of Yabase field.

In November, two of Imperial's petroleum engineers visited the United States to investigate recent developments in drilling and production techniques, secondary recovery methods, and reservoir engineering.

Economic Trends

Considerable encouragement was given to oil producers by an increase in the price of local crude oil in July to *Y1,482 per barrel ($4.10 per barrel at the current official exchange rate of Y360 to $1.00). Production by the smaller producers increased notably as a result, and Imperial Oil Company was able to execute additional projects during the last half of the year.

In October, Imperial successfully floated a new issue of stock which increased its capital from Y460,000,000 to Y1,000,000,000. An amendment to the Imperial Oil Company Law permitted all the new issue to be taken up by private interests instead of the 50 per cent holding by the government required by the Law. The market price of Imperial shares rose sharply from Y20 at the beginning of the year after the labor situation was settled, and reached a peak of Y380 in August after the announcement of the new crude oil price and the discoveries in Yabase field. The general recession in the stock market during the latter half of 1949 and the floating of the new capital issue reduced the share price to Y120 in October, with a further recession to Y80 late in December.

*Y represents yen.

Legislative Changes

Imperial Oil Company was released from designation as an excessive concentration of economic power after complying with the order to dispose of holdings in other companies and to relinquish prospecting leases on which no active exploration bearing on the leases had been conducted in the past five years.

The question of repeal of the Imperial Oil Company Law to place it in the status of a normal private enterprise was under consideration by the Japanese Government, and a draft for an amended Petroleum Resources Development Law was formulated with the object of reducing the degree and type of government control over the producing industry and encouraging exploration for new reserves.

Draft revisions of the Mining Law included a provision for limiting the holding of mineral prospecting rights to a short term so that large areas could not be held indefinitely without any exploration activity, as was the practice formerly.

Covered Derricks

Gigantic "slip covers" for derricks that are soundproof, waterproof, and fireproof are proving helpful in the drilling of oil wells in restricted areas where noise and mud spray cannot be tolerated. The derrick coverings muffle 90 per cent of the normal rig noises and, in addition, provide an extra safety margin from the dangers of fire and oil or mud splatterings. Constructed of multi-layer fabric materials, the covers can be installed or removed easily and, with proper care, can be used many times.

Changes In Company Status

Imperial Oil Company effected an important internal reorganization in its technical departments, which divided the former production department, controlled by drilling and production engineers, into an exploitation department, exploration department, and mechanical operations department. The latter acts as a service department for execution of the plans and projects developed by the evaluation branches of the exploitation and exploration departments. This reorganization broke a long tradition in the Japanese industry of control of both planning and operations by drilling engineers, who often paid little regard to the opinions of the petroleum geologists and exploitation engineers on their staffs.

Nippon Mining Company, whose principal business is mining copper and other ore minerals, re-entered the petroleum producing field by acquiring the exploitation rights of Nitto Oil Company in Hachimori field, Akita Prefecture and prospecting leases in Akita and Aomori Prefectures. Nippon Mining Company lost its petroleum producing department and leases when Imperial was established in 1941 but it has continued to operate its refinery at Funakawa, near Akita city.

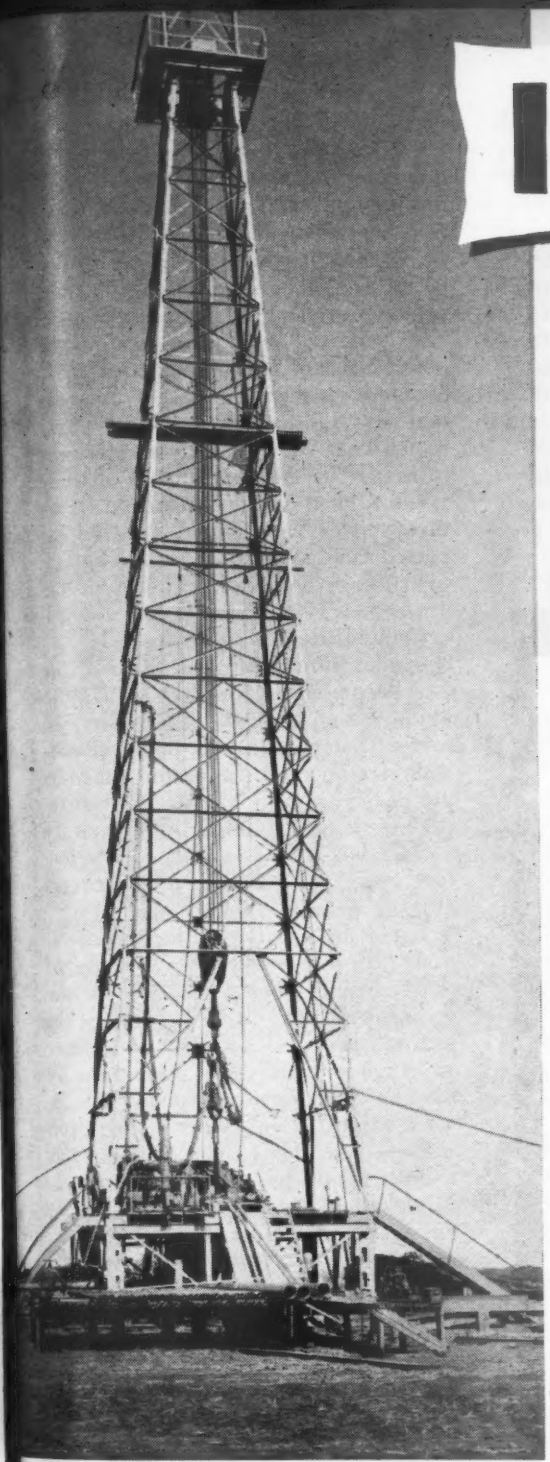
The Ube Oil Company's leases in Hachimori field were taken over by Fuji Mining Company, and the Nichibei Oil Mining Company took over the leases in Hibiki field formerly operated by Hibiki Oil Mining Company.

Natural Gas

Production of oilfield gas showed a slight decline from 2,250,000 cu ft daily in 1948 to 2,220,000 daily in 1949; decreases were mainly in Hokkaido and Akita fields while Nishiyama field, Niigata Prefecture showed a slight gain.

Production of methane gas, generally associated with saline artesian water, showed a tremendous artificial increase from 1,286,000 cu ft daily in 1948 to 4,417,000 daily in 1949. Most of this increase was due to the fact that production data were not previously recorded from many private companies that own producing gas wells in the Niigata methane gas field. In this area, recorded production jumped from 395,000 cu ft daily in 1948 to 2,730,000 daily in 1949. Other significant increases, however, were effected in the methane gas fields in Chiba Prefecture and Shizuoka Prefecture.

As a result of exploration during 1949, methane gas accumulations were discovered in the Osaka district and near Takaoka city, Toyama Prefec-



Two "Caterpillar" Diesel D17000 Oilfield Engines power this 120' rig at The Bearing Company operation near Luby, Texas.

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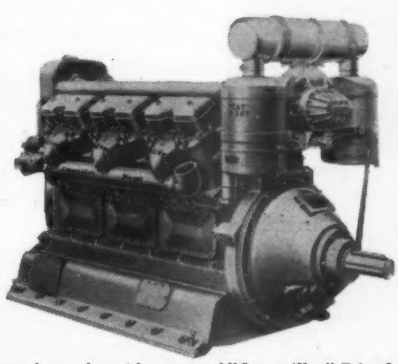

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OILFIELD ENGINES

ture. Many of the local government bodies in Japan are encouraging exploration and development of methane gas to provide both domestic and industrial fuel.

The Outlook

Production of crude oil during 1950 is expected to show an increase of more than 50 per cent over that of 1949. Already in January 1950, 155,050 bbl of crude were produced. Imperial's production of 147,190 bbl in January was the highest monthly production in its 9 years of existence.

The most significant factor in increasing production during 1950 will be Imperial's exploitation of the new deep zones in Yabase field; about 20 wells are scheduled for this program. Assuming a base daily production of 4763 bbl from February, and that this will be maintained during the year by new production brought in from the less significant fields, production from the new deep zone wells completed should bring the total production from 1950 to about 2,200,000 bbl, as compared with 1,368,050 bbl for 1949.

This estimate is considered reasonably conservative because it is based on the present twin-well drilling program tentatively proposed by Imperial Oil Company; if dual completions are attempted on zones VIII and IX, the production could be considerably increased. Also, the initial production rates used in the calculation of expected production are considered to be rather low. This estimate of production does not take into account the possibilities of other production from exploitation during the year of areas that may be proved productive early in the year by exploration wells now drilling. The most significant of these is the wildcat on the Tsuchizaki structure west of Yabase field. It is not expected that exploitation of Kawaguchi field, in northern Hokkaido, would begin before 1951, if the deep test wildcat now drilling is successful.

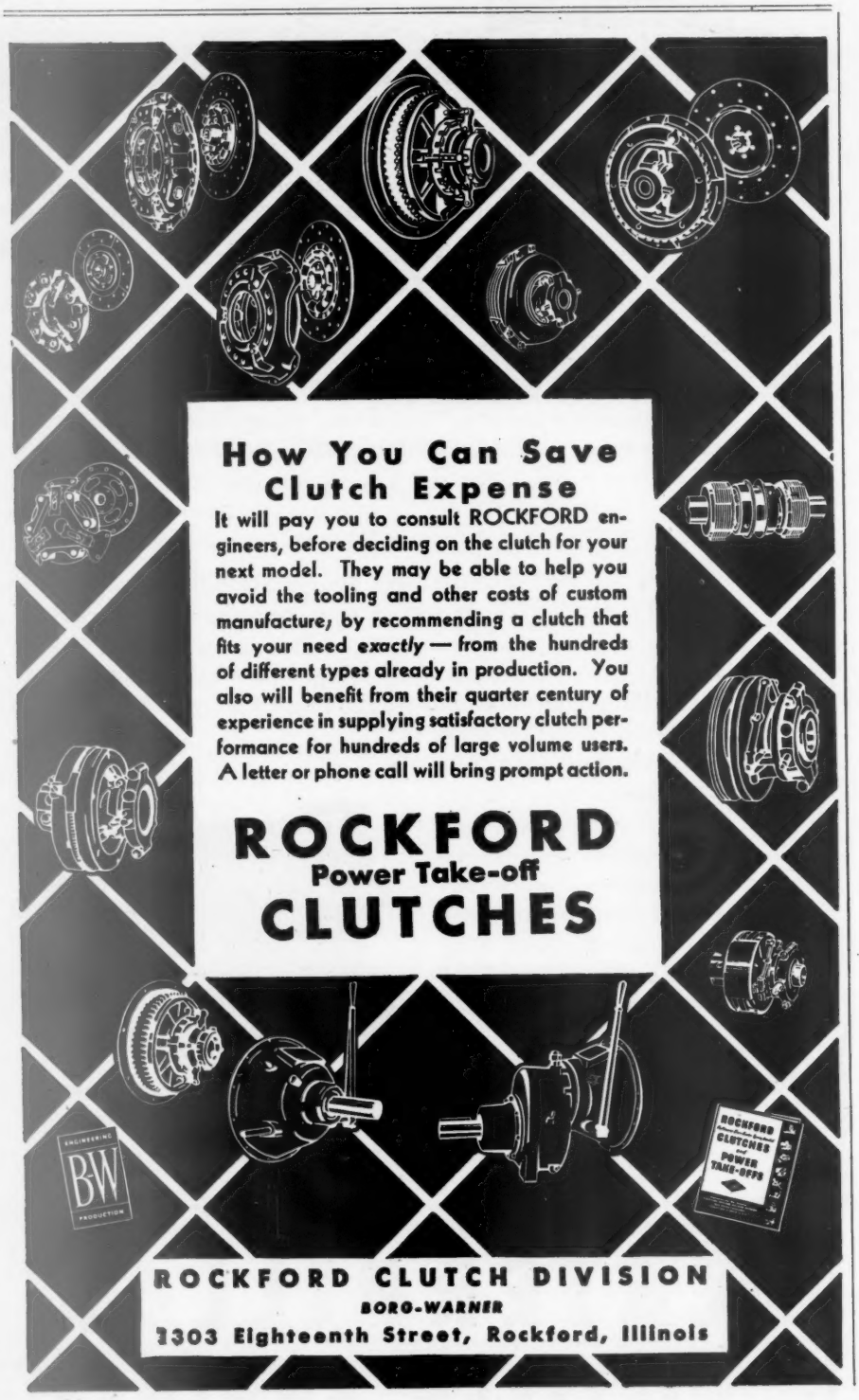
Exploration drilling is planned for new deep pools in Karumai field, Hokkaido, for about 6 wildcats in Honshu, for extensions and new pools in possible stratigraphic traps along the margin of the basin in Niigata Prefecture, for new fault trap pools in the vicinity of Narahashi field, Yamagata Prefecture, and for extensions in several Honshu fields.

Exploration survey will continue at a slightly diminished rate because of the reduced subsidy granted by the government for oil exploration, but this will probably be offset by greater coverage in geophysical operations by the use of the new geophysical equipment imported in 1949. Exploration surveys and drilling for methane gas will be conducted in Aomori, Akita, Yamagata, Niigata, Chiba, Toyama, Shizuoka, and Ishikawa Prefectures, and in the Tokyo and Osaka districts.

Drilling and production techniques should show considerable improvement as a result of the visit of Japanese petroleum engineers to the United States early in 1950, and it is expected that water flooding will be attempted in the shallow zones of Yabase field and dual completion practice applied to the deep zones of Yabase field.

Oil Is Free Enterprise

On March 25, 1950 an important stage was reached in reorganization of the structure of the Japanese petroleum industry by passage through the Diet of a bill for the repeal of the Imperial Oil Company Law of 1941. Repeal of this Law accords Imperial Oil the status of a normal private enterprise free from government control of its business operations and without benefit of special privileges accorded by its former status as a partly government-owned corporation. This repeal follows the general policy of placing all phases of the Japanese petroleum industry in the hands of private enterprise.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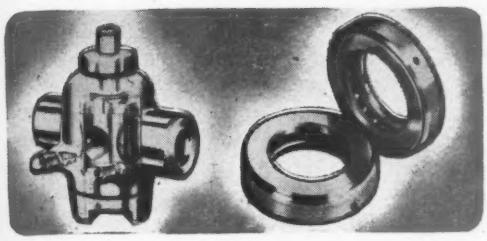

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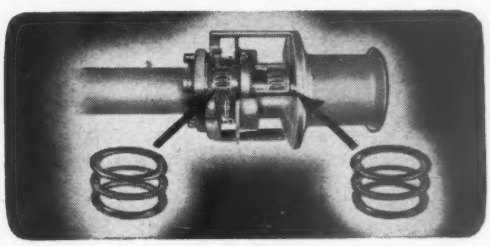

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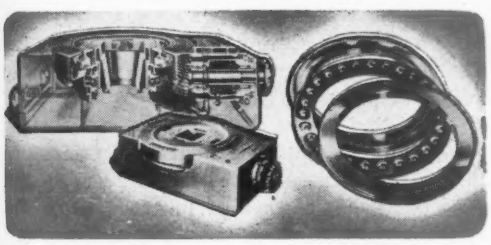

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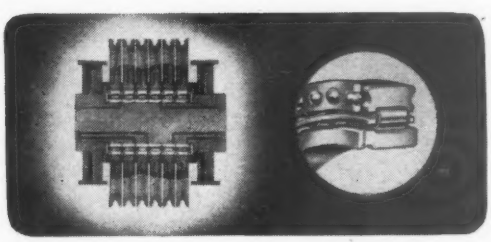

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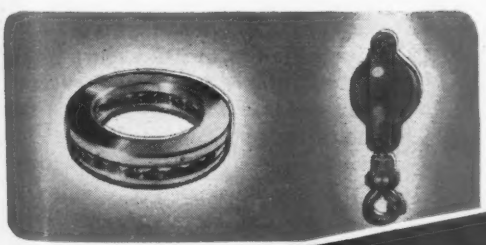

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Corrosive Environments and Methods of Mitigation in Producing Sour Crude*

D. A. SHOCK† AND J. D. SUDBURY†

IT is surprising to find that with the large amount of sour crude produced, most of which is corrosive, very little has been done of a fundamental nature in studying the corrosive reactions which take place. The technology of sour crude production has produced many practical methods of mitigation and perhaps has been successful enough that it has seemed unnecessary to initiate a more fundamental approach. In the past five years, however, there has been increasing interest in obtaining more fundamental data. This is due in part to the realization that without more and better basic data, further improvement in mitigation methods would be haphazard. It was also apparent that comparative evaluation of the mitigation methods were impossible without knowing more of the corrosion controlling factors. With the increasing stress on cutting production costs, we should expect to find a greater stress on obtaining better methods of corrosion mitigation. Thus, it seems an appropriate time to encourage research which will aid in solving these problems.

The objective of this paper is to review the facts that are known about the corrosion mechanisms taking place in sour crude production and to point out the factors which should have an influence on the type and rate of corrosion. This review is meant to serve as a basis for initiating laboratory research which recognizes the factors existing in the field, point out the areas in which fundamental work needs to be done, and indicate the present development of the mitigation methods.

Various Corrosive Environments

As a starting basis for considering sour crude corrosion, it seems highly desirable to stress the point that there are several different types of corrosive environments which occur during the production and subsequent handling of the crude. While workers actively engaged in corrosion work recognize these different environments as being present, there is a general tendency to classify all sour crude corrosion as sulfide corrosion with no reference to the particular environment in which the corrosion originated. As a consequence, remedial measures are often misapplied due to the fact that these differences are not recognized. Certainly, these various environments must be recognized in any fundamental study of the corrosion mechanisms. While it is possible that more divisions could be made, the following seem to be the most basic:

1. The well environment—this environment exists where the total produced fluids contact the equipment usually at fairly high velocities.
2. The aqueous environment—this environment exists where the water has separated from the oil.
3. The hydrocarbon environment—this environment exists where the crude exists above.
4. The vapor environment—this environment exists where the vapor in the vapor space above the crude or where the gas has separated from the other produced fluids.

Well Environment

The well environment is probably subject to more variables and is the least consistent in comparative behavior than any of the others we are to consider. This is due to the fact that very little is known about the factors which are important in influencing rates of corrosion so that correlations of behavior are made between systems which are fundamentally unlike. Thus, the data which are essential to judge the corrosive character of a certain well system are never taken because we do not recognize it as necessary. From the work done on sour crude and particularly the fundamental research which has been done on corrosive sweet crudes and condensate wells, we can outline some of the factors which would influence the corrosive character of the well environment.

It has been well established that the presence of water is necessary for corrosive attack to take place. While H_2S is commonly thought of as the only corrodent to be in sour crude, we now know that there is sufficient CO_2 present in many sour crude wells to produce a severely corrosive environment. Recently, our laboratory has found that the lower fatty acids, such as acetic, are found in many produced waters of corrosive sweet crudes; therefore, we should not overlook the possibility that other corrodents than H_2S can influence the severity of corrosion. Oxygen has been shown to accelerate corrosion if it is introduced into a well; however, this condition is not usually encountered unless a well is being pumped under vacuum. Oxygen has not been found in well constituents which are uncontaminated by air.

With corrodents that are gases such as H_2S and CO_2 and where the corrosive action is dependent on their being dissolved in water, the concentration of corrodent depends on the solubility of those gases in the water. This means that the solubility is greater with a decrease in temperature and increases with the increase of the partial pressure of the gas. Thus, the two factors which affect the concentration of corrodents H_2S and H_2CO_3 in a well work against each other. The temperature drop increases solubility and the pressure drop decreases solubility. It also follows that from well to well, where there is pressure and concentration variation of gas, it is possible to have a wide range in corrodent concentration. It is important, therefore, to know the operating temperatures and pressures as well as the corrosive gas content if corrosive situations are to be compared.

In addition to the concentration of corrodent, there are other factors which are known to influence the rate of attack in well systems. Rogers[2] has shown that using the same corrosive conditions, the corrosion rate decreases as the oil increases. Thus, wells producing a high oil to water ratio are very slightly corrosive compared to those producing under the same conditions but with a low oil to water ratio. Another factor is the buffering action and solubility limitation

*Presented at the Spring Meeting of the Rocky Mountain District, API Division of Production, Gladstone Hotel, Casper, Wyoming, April 14, 1950.

†Continental Oil Company, Ponca City, Okla.

due to dissolved salts which can have a retarding action on the rate of attack. Additions of neutralizing and buffering compounds are now common means of mitigating corrosion in condensate wells. On the other hand, it is possible that some salts may accelerate well environment corrosion. This, however, has not been established as any major effect. Velocity of produced fluids has two effects. The one of major importance is the effect of moving more corrodent across the metal surface, the other is the erosion effect which removes any protective or semi-protective layers that may have formed on the metal surface. Both of these accelerate the rate.

Associated with the corrosion which takes place is the phenomena of hydrogen embrittlement and blistering. These phenomena are peculiar to the production of sour crude and are responsible for a large part of the corrosion costs. Both embrittlement and blistering are believed to be caused by the production of atomic hydrogen produced by the corrosive reaction. In the case of embrittlement, the atomic hydrogen is absorbed in the steel in such a manner that the metal breaks under stress. With blistering, the hydrogen penetrates through the metal until stopped by a barrier or encounters a void, then the atomic hydrogen unites to become molecular hydrogen. The pressure of the molecular hydrogen builds up and disrupts the metal usually forming blisters but sometimes completely breaking out a piece of metal. In some of the earliest work on sour crude, Vollmer and Westcott[3] showed that water and well brine saturated with H_2S would embrittle drilling lines. The effect of atomic hydrogen from sour crude corrosion is similar to the same phenomena resulting from the action of the strongest acids on steel such as in the pickling of steel and in hydrofluonic acid alkalination. Including the work done on the stronger acids, considerable work has been done on the effect of atomic hydrogen. Nevertheless, the information on the factors which promote or inhibit the hydrogen formation and diffusion are still not well understood. A better understanding of the metallurgical requirements for a steel which would resist embrittlement needs continued investigation. The following references are some of those pertinent to the problem.[4, 5, 6, 7, 8, 9]

Types of Corrosion and Remedial Measures

The appearance of the corrosion taking place in the well environment is generally a pit attack. This occurs on tubing, sucker rods, and line pipe. Failures due to embrittlement usually come when the metal has been under stress as in sucker rods and parts of pumps. Mitigation methods are aimed at stopping the corrosion, which if it is accomplished, stops the effects of any produced atomic hydrogen. We have three general classes of mitigation methods. First are the alloys, second the coatings, and third the inhibitors. The alloys which are serviceable are those of high alloying constituents and generally too expensive to be used in any except the most severe service. K monel, Inconel, and various types of high chromium nickel steels resist attack and embrittlement but are too expensive to be used in tubing. Some use of K monel is made in sucker rods, but usually lower first cost methods are favored. The field of coatings is more widely used, both organic and inorganic. All coatings suffer from the disadvantage that, after the coating has been penetrated, attack and ultimate failure will take place. Thus, success in most cases depends on the length of time they adhere to the basic metal as a continuous protective film. Various plastic coated tube and sucker rods are available. Sprayed and dipped metal coatings such as Monel and zinc galvanizing have shown some corrosion resistant properties. Tubing has been cement lined by a centrifugal process which has been in use for several years by one of the sulfur companies under conditions much more severe than sour crude production. Line pipe is now being produced by the same method; however, no performance data have been received. Surface lines are also being given a continuous rubber lining which seems to give a good performance. Inhibitors thus far developed which are in service have been formaldehyde,[10] the Kontol inhibitors made by Tretolite Company, and wetting agents to give continuous oil films as described by Rogers.[2]

Corrosion in Heaters and Treaters

The well environment was extended to include the various types of emulsion breaking systems. These may justify another environment class for they employ heat, the produced fluids become separated, and the well fluids may have had a primary separation stage. It is evident that the corrosion performance of the various types and locations of separation equipment should not be compared unless it is known that the environments are the same. The potential corrodents are the same as those mentioned under the well environment. Heat increases the reaction rate of the corrodents. Not only are these corrodents more aggressive, but also the sulfur compounds in the petroleum become corrosive if sufficient temperature is reached.[11] Alloys, thus far, are the best solution in stopping corrosion though expensive in first cost. An inexpensive method has not been found. Various coatings have been tried as well as cathodic protection methods; however, there is no published data on the comparative effectiveness of mitigation methods.

Water, Oil and Gas Environments

The remaining three environments and their mitigation methods are best discussed together. These environments, while occurring separately in other places through the production system, are responsible for a large portion of field corrosion as they occur together in the lease and storage tanks. Therefore, they will be discussed together with principal stress on how they occur in storage tanks.

Water Zone Environment. The corrosive reactions in the water environment are those which are due not only to active corrosive agents H_2S, H_2CO_3, etc., but also galvanic and possibly concentration cell corrosion. With a large excess of H_2S present, there is no evidence that there is also dissolved oxygen present; however, if oxygen enters the system, a precipitate of sulfur is formed thus producing another corrodent. Formation of the oxygenated sulfur acids H_2SO_4 and H_2SO_3 has been postulated as another corrosive agent but not definitely proved. Under these conditions, corrosive attack can proceed along a number of different paths. It is possible to have galvanic corrosion take place due to particles of scale which have fallen from the roof or have been produced at the bottom and flaked off. It can be readily seen that no single simple corrosive reaction can be written which will show how corrosion progresses in this zone. Successful mitigation methods must eliminate the effect of all these various corrosive reactions.

Oil Zone Environment. The oil zone environment is the least corrosive of any of those we are to consider. There is good evidence to show that the major portion of this corrosion is due to H_2S dissolved in water emulsified in water in the oil. Sheppard[12] cites results obtained by Walter F. Rogers showing H_2S contents in oil as low as 0.1 per cent by weight would promote rapid corrosion in pipe line oil. While penetration rates in the oil zone are comparatively low, hydrogen

blistering is quite prevalent. In order to produce the hydrogen for this blistering to take place, some corrosion must take place. Information is badly needed which would better define the conditions which produce hydrogen blistering in the oil environment.

The Vapor Environment. The corrosion taking place in the vapor space is probably the most troublesome of the zones in storage tanks. Here a number of corrosive reactions can take place; and, while the work of Devine, Wilhelm, and Schmidt[1] and Bond and Marsh[13] have laid some excellent ground work in a study of the corrosive reactions, much needs to be done to further the knowledge. Oxygen, water, hydrogen sulfide, and sulfur combine to give the corrosive environment. The corrosive reactions take place principally in the condensed droplets on the dampened surface. Hydrogen sulfide from the vapor space dissolves in the droplets of water and sulfide attack occurs. Oxygen can react with the dissolved H_2S producing S. Oxygen also unites directly with the iron in the moist atmosphere and produced hydrous oxides. These iron oxides react with either H_2S or fairly divided sulfur producing further attack. The corrosion products of the oxides, sulfide, and free sulfur are all non-protective and usually porous so that no protection is afforded by their formation. Instead, they tend to hold the condensed moisture stimulating further corrosion. It has been shown also that the variation in H_2S and oxygen content varies the rate of attack and corrosion product formed.

The reports of research[1, 13] have given some basis on which to predict corrosive behavior on the basis of physical conditions and chemical analysis. As such, they are a step in the right direction in placing corrosion predictions on a sounder basis and give a better starting point in evaluating mitigation methods.

Mitigation Methods

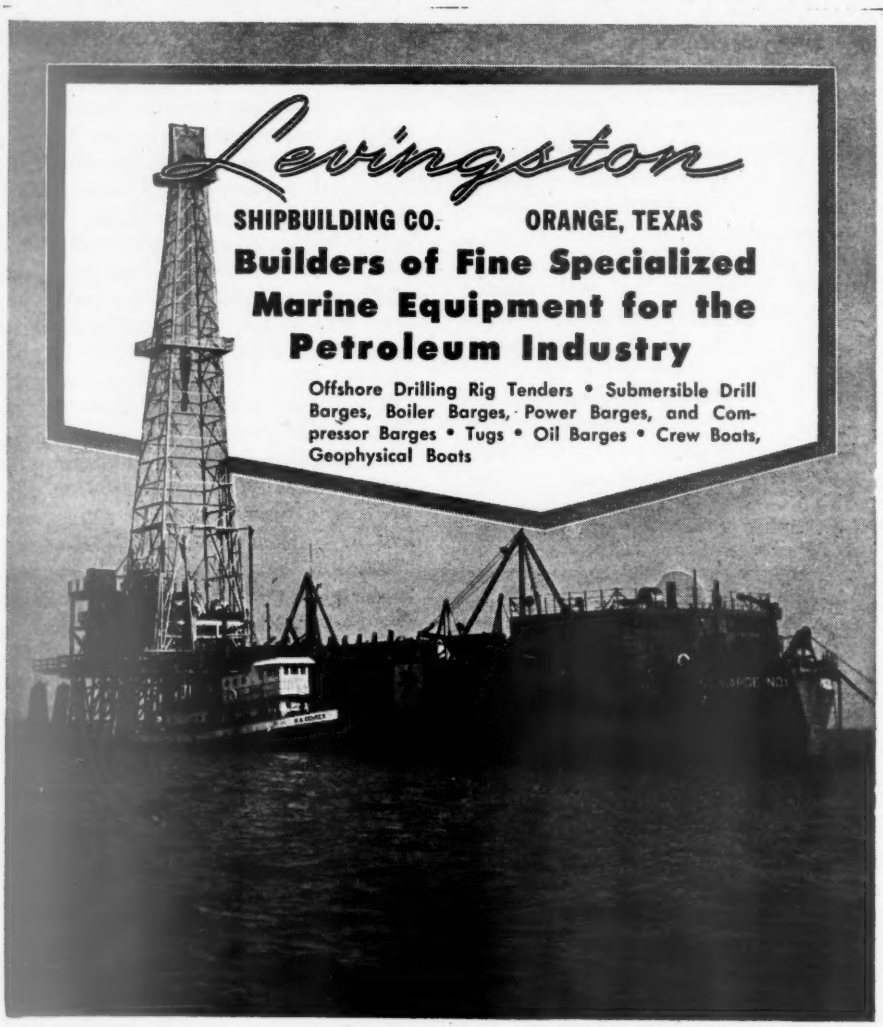
There has not yet been developed a method which satisfactorily combats the three types of corrosive environments found in storage tanks. The mitigation methods are often different for each corrosive zone. The principal methods are discussed below.

Coatings. The coating materials come nearest to achieving a single mitigation method. Various formulations of the plastic paints show some promise; however, they lack much in being completely successful. Hydrocarbon permeability, poor adhesion, inability to withstand mechanical shock, and cost of application are all factors which keep the plastic coatings to date only partially satisfactory. The bitumen and asphalt base paints are very successful when properly applied on the bottoms of tanks protecting water zone corrosion. They are less so on the sides and deck due to their plastic flow and solubility. These coatings seem to have definite advantages over the newer types of plastic and for the tank bottoms.

Inorganic coatings such as galvanizing have given good service in numerous corrosive areas, particularly in the vapor zone and oil zone as well as exterior. The failures seem to come mostly in the water zone where the salt water attacks the zinc rapidly, and, when the zinc is removed, corrosion of the steel takes place. From work on tubing sulfur wells, it was found that the addition of small amounts of Mg and Al to zinc gave a galvanizing coating which was much more resistant to salt water and sulfur corrosion than ordinary zinc galvanizing.[14] This alloy galvanizing may prove of use in such salt water service. Cement lining such as gunniteing has given good service in all three zones. Here again cost puts an economic limitation on its widespread use.

Metal Alloys and Design. Aluminum has been found to have excellent resistance to vapor space corrosion, but it has poor resistance to the water environment. Its use for decks and rings in combination with other types of corrosion resisting methods for the other two zones has given a means of combating tank corrosion. Cone bottom tanks, which have a slight taper and a center sump for water collection reduces the area covered by the water environment. The center sump in which the water collects is made of monel to resist the water zone corrosion. A combination aluminum deck, cone bottom, and monel sump has recently been put on the market combining these features.

Vapor Space Inhibitors. Gardner, Clothier, and Corvell have described the use of ammonia for corrosion control in the vapor space.[15] They show that a concentration as low as 0.4 per cent of ammonia can stifle the corrosion of two per cent H_2S gas mixtures. Checking this work in our laboratory, we have concluded that the protection afforded is due to the rise of the pH in the condensed water droplets. Ammonia is considerably more soluble than H_2S so that very little of the ammonia is required in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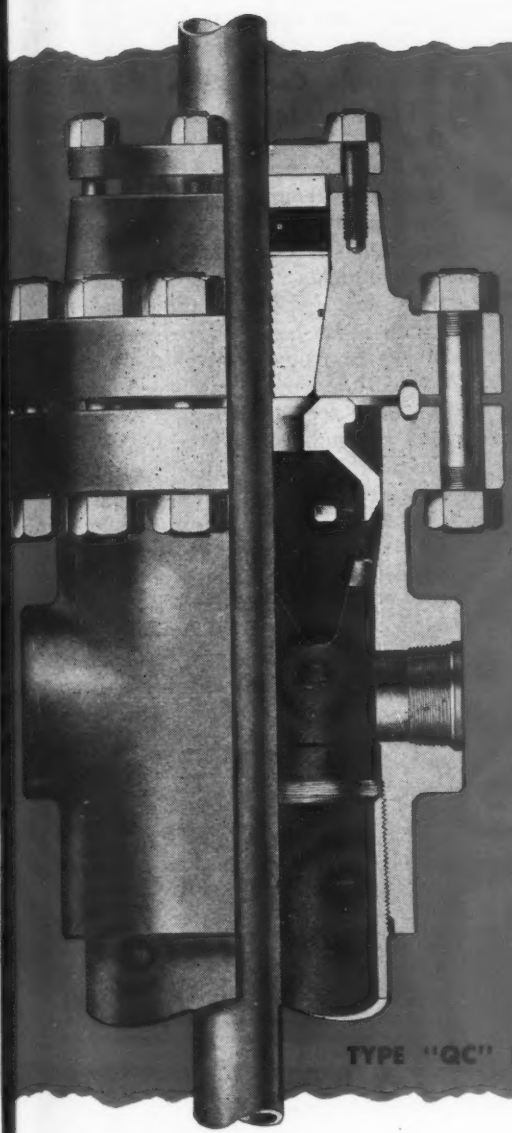

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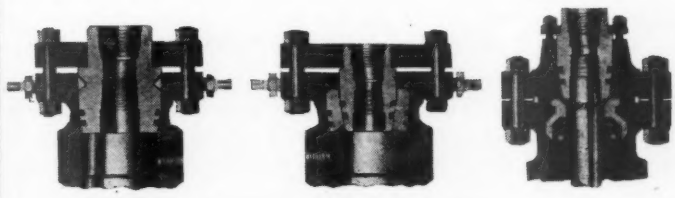

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the vapor phase in order to neutralize the dissolved H_2S in water droplets on the side of the tank and bring the pH of the solution to a value such that the corrosion of iron either by sulfide or by oxygen proceeds at a very slow rate. While ammonia is not a true inhibitor, its present use suggests the possibility that vapor zone inhibitors could be developed which could be applied in a similar manner.

Minimizing Corrosion by Operating Practices. Since it is evident that oxygen greatly accelerates corrosion,[13] it is logical to assume that the life of a tank could be lengthened by excluding it. We have several tanks now under test which maintain a natural gas atmosphere in draw down and no air is pulled into the tank. Another measure, as shown from results on coupons placed inside a sour crude storage tank, indicates that occasional wetting of the steel in the vapor space with crude reduces the rate of attack. Spray systems which were supposed to spray the crude over the top have not been entirely successful in the field. These field difficulties have in some cases been due to the spray not thoroughly wetting the entire surface.

As the final point, it should be kept in mind that any method of removing or reducing the concentration of the corrodents or the medium in which they are active (water) will result in a decreased rate of corrosion. Thus, completely removing or excluding liquid water and neutralizing or fixing the sulfide should be beneficial.

Conclusions

From this brief review, we can see that the corrosion experience in producing sour crude is a complex problem. The grouping of the corrosive environments is an attempt at simplification. On examining each of the environments, it was evident that there are gaps in our information which must be filled before we can place corrosion control methods in sour crude on an engineering basis. We have seen that numerous mitigation methods exist for all the environments. Our evaluation method and comparative effectiveness estimates to evaluate these mitigation methods are far from the point of development where they will establish engineering answers. The job ahead is to fill in the necessary fundamental information and to improve our test methods to where we can choose the most economical mitigation methods.

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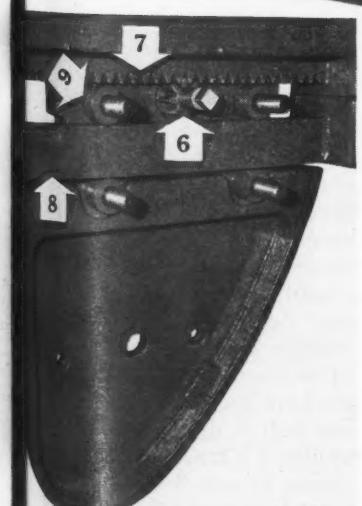

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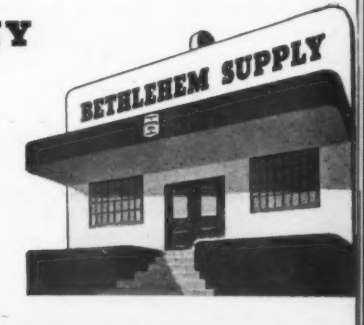

Discovery and Development of Crude Oil and Gas Reserves in Cheyenne County, Nebraska*

WILLIAM L. HERSHELMAN†

On May 14, 1949, The Ohio Oil Company at its Mary Egging No. 1 Sec. 11, T. 15 N., R. 49 W., Cheyenne County, Nebraska, cored saturated sand at a depth of 4406 to 4409. This show of oil has led to the development of the Gurley field and more recently to the Huntsman field and proved that given favorable structural conditions oil has been accumulated in commercial quantities on the eastern side of the Julesburg Basin.

It will be the scope of this paper to give some of the exploration history prior to discovery and to bring the field development up to date. Needless to say, there is much information which cannot be made public at this time, but the author wishes to thank The Ohio Oil Company for making available the information which it was necessary to draw from their files.

Cheyenne County, Nebraska, is the central county of three counties in the panhandle of Nebraska that border on Colorado. The county is crossed from east to west by the main line of the Union Pacific R. R. and U. S. Highway 30 and from north to south by the Chicago, Burlington and Quincy R. R. and State Highway No. 19.

Most of Cheyenne County is flat and quite level. It is ideal land for raising winter wheat and this is the staple crop of the area. One major drainage, the Lodgepole Valley, has been eroded into the otherwise level upland plain to a depth of 200 ft and adjacent to this major drainageway some of the topography is very rough and broken. Lodgepole Creek flows from west to east across the county.

Cheyenne County lies in the Julesburg Basin about 80 miles southwest from the Chadron Arch, and about 1500 to 1900 ft down dip from the crest of the arch in the vicinity of Hyannis, Grant County, Nebraska. The regional dip in the Basin continues to the west and southwest for about another 100 miles or until it gets very close to the Rocky Mountain Front in the vicinity of Cheyenne, Wyoming, and Denver, Colorado.

The surface formations in Cheyenne County are of Tertiary age. This blanket of Tertiary is approximately 1000 ft thick at a maximum. The structural attitude of the underlying Cretaceous and older formations is completely masked by the Tertiary. In fact, the Tertiary dips generally to the east, while the older beds dip to the west.

Directly underlying the Tertiary is the Pierre Shale, of Cretaceous age. Approximately 2700 ft of Pierre is present in the county. In descending order the remainder of the Cretaceous is as follows:

Niobrara Limy Shale	250 ft
Ft. Hays Limestone	100 ft
Codell Sand	11 ft
Upper Benton Shale	172 ft
Greenhorn Limestone	25 ft
Lower Benton Shale	220 ft

"So called" Dakota sands and shale, which include the pay section at Gurley and Huntsman—200 ft.

"So called" Fuson shale 153 ft.

"So called" Lakota sands and shale 220 ft.

The Knievel No. 1 well in the Gurley field was bottomed after drilling 64 ft of light green shale believed to be Morrison.

So much of the section as has been described above is known from actual drilling in the area. The remainder of the section can be inferred from deep wells. The closest well to the area which drilled the Pre-Cretaceous section is the Sinclair Delatour in Sec 33—T 19N—R 45W. Garden County, Nebraska, or about 50 miles to the northeast. Sinclair drilled this well in 1944 with rotary tools to a depth of 5445 or 5 ft into the Pre-Cambrian complex. The Schlumberger log of this well is available. Scout tops of the log show Sinclair drilled 249 ft of Morrison, 738 ft of shale anhydrite and dolomite believed to be Permian, 470 ft of Pennsylvanian shales and limestone, and 45 ft of basal sands of Pennsylvanian to Pre-Cambrian age. From this log it may be seen that a large portion of the Paleozoic section is missing.

For many years the Julesburg Basin has been considered an excellent structural province in which to explore for oil. The thick Cretaceous shale section was known to be petroliferous, and potential reservoir rocks were known to be present in the form of the Muddy, Dakota, and Lakota sands. The occurrence of oil in the Muddy sands of the Greasewood field, in Sec 6—T 6N—R 61W, Weld County, Colorado, intensified interest in the area. The question was to find what circumstances were necessary to cause the accumulation of oil, and then to determine the locations where those conditions existed.

The Ohio Oil Company initiated a seismic program in 1943 and carried it on into 1944. During this portion of the program, work was started in the vicinity of Greeley, Colorado, and carried eastward to the vicinity of Sterling and Akron, Colorado. Following this initial phase of geophysical work the Ohio drilled its Nordloh well in Sec 20—T 5N—R 63W, Weld County, Colorado, and the Tidewater Associated drilled two farm out wells in Sec 30—T 5N—R 60W, Morgan County, Colorado, and in Sec 1—T 3N—R 61W, Weld County, Colorado. These wells were drilled through the Dakota sands on features of small structural closure, and all were dry.

The second phase of exploration was started in 1946 and carried eastward from Sterling to the vicinity of Imperial, Nebraska, and northward to Bridgeport and Oshkosh, Nebraska. Structural conditions favorable for the accumulation of oil were encountered in Cheyenne County, Nebraska, and after leases were taken the Egging location was selected for drilling, with the results mentioned above.

The Gurley field is located on a structural feature which has in excess of 100 ft of independent closure. To date 10 wells have been drilled in the field and one well is drilling. Of the 10 wells completed 7 are oil wells and 3 are dry holes. Of the 3 dry holes, one is a failure because of the inability to shut off water in the bottom of the hole, and the other two are suspended pending deeper drilling. Of the 7 producing wells, 6 are producing from the first bench of the "so called" Dakota and one well pro-

*Presented before the Spring Meeting of the Rocky Mountain District, API Division of Production, Gladstone Hotel, Casper, Wyoming, April 14, 1950.

†The Ohio Oil Company, Casper, Wyoming.

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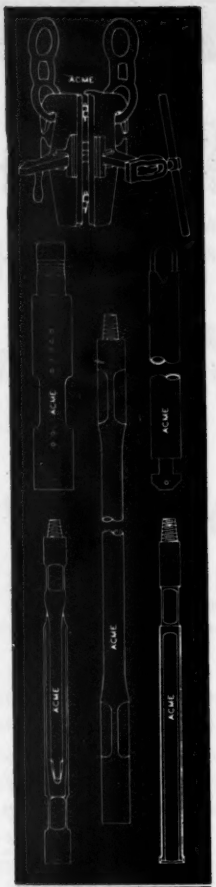

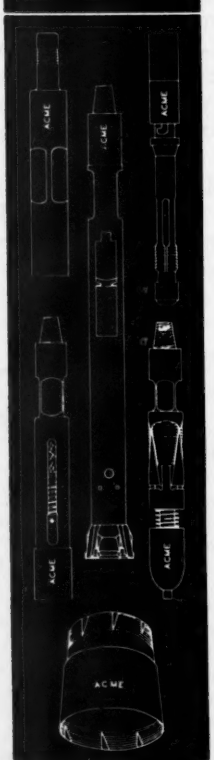

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duces from the third bench. The producing wells all require pumps to lift the oil to the surface and average over 100 bbl of oil per day per well.

The producing section at Gurley consists of 3 major sand bodies. The first bench of sand consists of 50 ft of sand with black shale breaks in the sand. The shale breaks aggregate 16 ft and the thickest one is 5 ft thick. Between the first and second sands is 12 ft of the black shale. The second sand bench is 28 ft thick and is a homegenous sand without shale breaks. In all cases the second sand has contained salt water and drillstem tests may show a small amount of gas; 46 ft of black shale separates the second bench of sand from the third. The third bench of sand is 64 ft thick and of fairly homogeneous sand. The top 22 ft, however, is usually very silty and non-porous.

Generally speaking, the physical properties of the sandstones of the producing sections are excellent. The individual grains are rounded quartz grains which are not too tightly cemented. Porosities average in excess of 17 per cent, and some of the permeabilities exceed 1000 millidarcies.

The oil from the Gurley field is greenish brown and 35 gravity; it contains only 24/100ths of one per cent sulfur; the viscosity at 100 F is 59 sec, and it pours down to 60 F. The Gurley oil contains some solution gas but it is undersaturated in the reservoir.

In November, 1949, The Ohio moved away from the Gurley field and located the No. 1 Cruise in Sec 7—T 14N—R 49W, on a second structural feature known as the Huntsman. The Huntsman structure lies eight miles southwest of the Gurley field and is a feature with more than 100 ft of independent closure. The drill topped the first sand bench of the "so called" Dakota in the No. 1 Cruise at 4620 and subsequent drillstem tests showed the formation to be very tight. The second sand carried water with some gas. The third sand was found at a depth of 4744 and drillstem tests through the entire sand section showed gas in quantity. Drilling on the Cruise was carried into the Morrison to test the deeper Cretaceous sands but no commercial production was found below the third bench of the "so called" Dakota. After the No. 1 Cruise had been cleaned up tests through the casing showed the well capable of making 54,000,000 cu ft of gas per day.

Next, The Ohio moved about 1½ miles to the northwest from the Cruise and located the Mather No. 1 in Sec 12—T 14N—R 50W. At the Mather location the first bench of "so-called" Dakota sand was found at 4663, and again the sand of the first bench was too tight and silty to produce. The second bench carried water with some gas. The third bench was topped at 4802 and 65 ft of gas sand was drilled. The Mather has been completed for about 12,000,000 cu ft of gas through the tubing.

After the Mather, The Ohio moved another 1½ miles to the northwest to locate the Gurschke No. 1 in Sec 3—T 14N—R 50 W. At the Gurschke, the first bench of "so called" Dakota sand was topped at 4719 ft. A drillstem test from 4720 to 4730 recovered 120 ft of oil and gas cut mud. This was similar to the recovery for the drill stem tests at the Mather and Cruise in the top of the first sand bench; however, the next test from 4729 to 4743 recovered 3094 of heavily gas cut green oil, 728 ft of gasoline cut oil, and 91 ft of water, with a gas flow of from 9000 to 12,000 cu ft per day. The third drillstem test in the first sand bench from 4743 to 4758 recovered 2940 ft of mud and gas cut green oil with a gas flow of 15,000 cu ft of gas per day. Thus, the Gurschke well established the presence of oil in the first bench of sand on the Huntsman structure.

The second bench of sand in the Gurschke carried water, but the third bench again proved productive. The third bench of sand was entered at a minus 512-ft sea level datum or at a depth of 65 ft below the same stratigraphic position at the No. 1 Cruise. The first drillstem test in the third bench of sand was over the interval from 4862 to 4872 and recovered 30 ft of gas cut mud and gas at the rate of 20,000 cu ft per day. The second drillstem test from 4872 to 4885 recovered 30 ft of gasoline cut mud and gas at a rate of 1,500,000 cu ft per day. The third drillstem test from 4886 to 4900 was made immediately under an 8-ft shale break, and the recovery measured 639 ft of oil, 90 ft of heavily gas cut mud, 30 ft of water, and gas at the rate of 20,000 cu ft per day. Thus, the presence of oil in the third bench of sand was established on the Huntsman structure. Subsequent drilling and testing through the remainder of the third bench of sand did not establish a definite oil-water contact in the vicinity of the No. 1 Gurschke.

In conclusion, I should like to point out that the Julesburg Basin is one of the major structural basins in the United States, and that very little is known about it yet. I am confident that the future will, however, uncover further substantial reserves in the Basin, and that we are just closing the first chapter in its development. ★★

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● American Iron Tubing Tool Joints are designed for use on tubing when it is used for completion, workover and deepening. In these joints the outside diameter and inside diameter of the tubing tool joint is the same as the outside diameter of the tubing coupling and the inside diameter of the tubing (as shown at right).

The use of tubing tool joints eliminates wear and abuse on the tubing and tubing coupling threads due to making and breaking of stands at the point where the tubing tool joints are installed on the string.

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In the manufacture of American Iron Tubing Tool Joints the most accurate heat-treating methods known are provided by our new controlled-atmosphere furnace, shown below. A section of our fully equipped tool joint plant is also shown below.

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AMERICAN OIL RESERVES†

C. W. TOMLINSON*

GEOLOGISTS, geophysicists, and paleontologists are your friends and employees. The best known type of service that they render is in exploration for oil. You producers follow up their leads—and your own hunches. You turn them into practical service to mankind by finding oil where their dreams, or yours, were right. Now dreams wouldn't be worth while if they weren't a bit wild. But the good ones help a lot in this business of supplying the free world with oil.

Keep it in mind, though, that no geologist ever knows in advance which of his dreams are going to pan out right. His pet ones may be worthless; and the best results may come from one he rates very low. It may come then for reasons he had not considered.

In the American Association of Petroleum Geologists, about a quarter of our 4500 active members are in the ranks of the independents—either as consulting geologists, or as small oil producers. The majority of petroleum geologists work at routine tasks of sample study, drafting, compiling data, and correlating logs, with only remote contact with the romance of actual discovery. Their work is vital, though. It is the stuff of which those dreams are woven. Study of past experience is an essential basis of new discoveries. Without these workers, in increasing numbers, only a fraction of your postwar discoveries would have been made as yet. And without the money to pay these men, and to drill and equip the wells they recommended, most of those discoveries would still be in the future. We have helped you to prove, in spite of gloomy forecasts, that the rate of discovery in United States can still be stimulated by a good price for oil. You proved it last year by finding in the United States nearly twice as much oil as we used.

Your able vice president and my good friend, Harold Fell, contributed to this result, as did many other independents. He did it in the less headline-making manner of finding commercial oil reserves that had been left behind in old fields, in the same old reservoirs; where early wells had been drilled to far apart to get maximum recovery. Harold hasn't been flooding or repressuring. Some reservoirs are too lenticular for successful application of those methods. He has just been drilling infill wells among the old ones. It's a type of secondary recovery that is well adapted to some shallow fields, though out of harmony with some engineering theory. If it produces oil at a profit, that's the meat of the cocoanut.

Infill drilling does make money in some cases, where the wells are cheap. Doesn't this fact justify restudy of the theory which holds that well spacing makes no difference? For 20 years you have heard it preached that a few wells will get just as much oil as many wells, from the same reservoir.

We have state boards or commissions to regulate the oil industry. In general, you and I have gotten along well with them: For they have realized that a healthy industry serves the public better than a sickly one, and they have been conscientious public servants.

Some of the hearings before these boards are clear sailing. In those cases, all of us are agreed as to what we want, and what we want seems obviously to the advantage of the public too. That makes it easy for the commissioners.

But occasionally we are ungrateful enough to put these good men in a tough spot. We come before them with experts who contradict other experts. One group claims that its method will result in the greatest public benefits. The other is sure that the opposite course will be far more beneficial. And the poor commissioner has to decide between them.

Well Spacing

One subject which has brought forth such arguments for thirty years back, is well spacing. There is still fire in it, and strong clash of opinion, though in recent years the advocates of wider and wider spacing have seemed to sweep the field, in the Mid-Continent and on the Gulf Coast. The Californians have been more conservative.

In a hearing to fix the proper spacing of wells in a new field, it is customary for witnesses to offer estimates of oil recovery. It has become a habit with many witnesses to use the same estimate of total recovery for 160-acre spacing as for 40; and for 40-acre spacing, the same as for 10. Yet Harold Fell has been drilling between 10-acre wells 30 years old, and expects the new ones to pay out.

A few years back the well-spacing committee of American Petroleum Institute performed an important service to the industry by assembling from many companies detailed engineering data and recovery statistics and estimates from over 100 oil fields. They included a great variety of reservoirs —in sand, in dolomite, in limestone; fields with natural water drive and fields with none. They ranged in depth from 1000 to 10,000 ft.

R. C. Craze and Stuart Buckley, engineers of Humble Oil and Refining company, published these data and reported that they could find in them no clear evidence of any relation between well spacing and recovery of oil.

However, over two-thirds of the fields covered were similar to this extent: They were in sand reservoirs, and had natural water drive. When these fields are studied separately in groups of limited depth range, the added recovery obtained by close spacing of wells appears very clearly. For example, 28 of these water-drive sand fields lie at depths between 2500 and 5000 ft. Eighteen of them had less than 20 acres per well, 10 had more than that. In fact, there were on the average four times as many acres per well in the wider-spaced 10 fields as in the closer-drilled 18. In the wide-spaced group, estimated ultimate recovery averaged only 458 bbl per acre-ft of pay. In the close-spaced fields, it averaged 900 bbl. That's a 96 per cent increase.

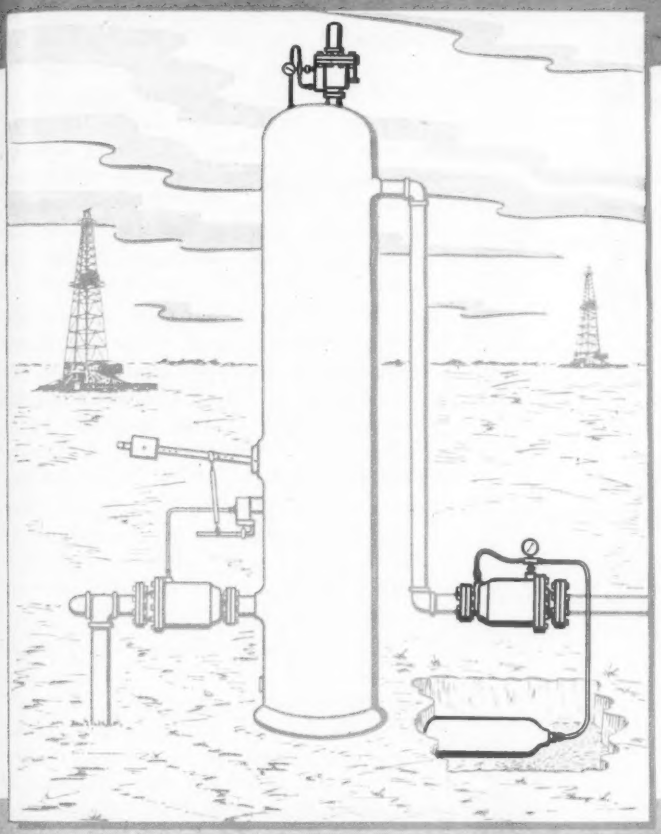
Had the 10 wide-spaced fields been drilled as closely as the others, and obtained thereby an equal recovery per acre-ft, they would have recovered 163,000,000 bbl more oil than they did. That would have required 2152 more wells; an average yield of 75,700 bbl per well. At an average cost of $40,000.00 per well, they would have had to clear 53 cents per bbl above

†Presented before the Mid-Year Meeting of Directors, IPAA, May 2, at New Orleans.

*President, American Association of Petroleum Geologists, 1949, and consulting geologist, Ardmore, Oklahoma.

GROVE

MODEL 888 PRESSURE LOADED RELIEVER



ON GAS SEPARATOR LINES

- HOLDS CONSTANT PRESSURE
- ASSURES TIGHT SHUT-OFF WITHOUT MOVING METAL PARTS

The unique operating principle of the Grove Model 888 Flexflo Reliever makes its action smooth and positive. This dependable service cannot be obtained from any other valve. There are no moving metal parts, springs, or weights to stick and jam. Pressure does the work, opening and closing the Flexflo Reliever with positive action.

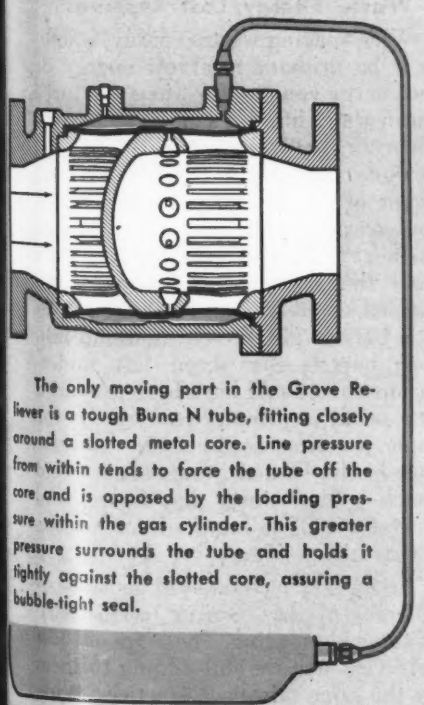
As a back pressure regulator, the Grove Reliever will unfailingly hold a constant pressure on the Separator and insure operation at maximum efficiency.

In the vent line the Grove Reliever will give dependable protection against excessive pressure and eliminate the expense and waste of leaking gas.

Specify Grove Model 888 Relievers with the proved Flexflo principle on your Separators for the best in efficient, trouble-free service.

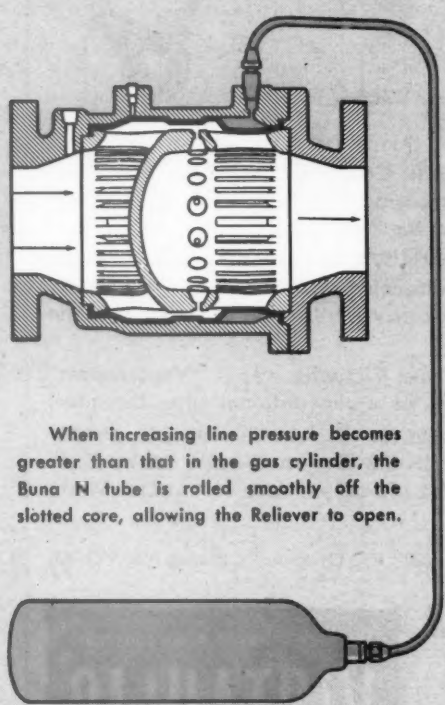
flexflo LETS PRESSURE DO THE WORK

CLOSED POSITION



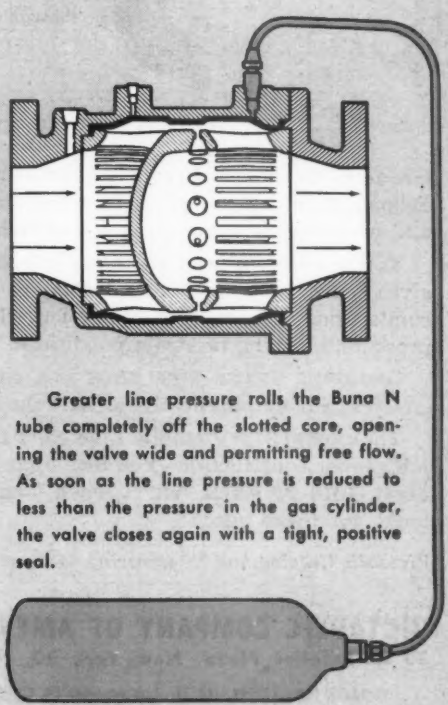
The only moving part in the Grove Reliever is a tough Buna N tube, fitting closely around a slotted metal core. Line pressure from within tends to force the tube off the core and is opposed by the loading pressure within the gas cylinder. This greater pressure surrounds the tube and holds it tightly against the slotted core, assuring a bubble-tight seal.

PARTIALLY OPEN POSITION



When increasing line pressure becomes greater than that in the gas cylinder, the Buna N tube is rolled smoothly off the slotted core, allowing the Reliever to open.

WIDE OPEN POSITION



Greater line pressure rolls the Buna N tube completely off the slotted core, opening the valve wide and permitting free flow. As soon as the line pressure is reduced to less than the pressure in the gas cylinder, the valve closes again with a tight, positive seal.

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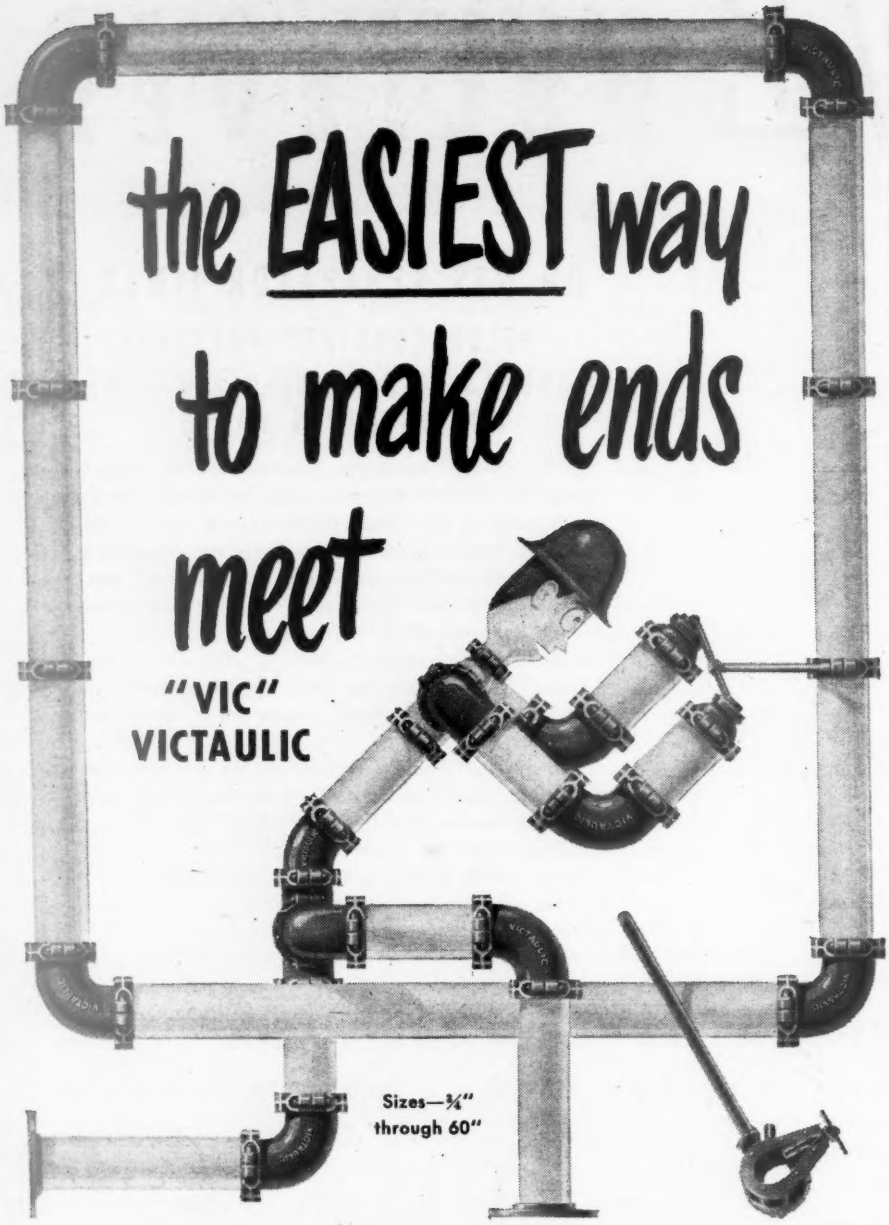

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PIPE COUPLINGS AND FITTINGS

operating costs to make an added profit on the extra wells. Some would have paid out, some would not, at the prices we have had for oil. In some fields, 10-acre spacing would have been most profitable; in others, 20. In deeper fields, even at good prices for oil, 40 acres or even more may be best. But the important thing is to recognize that, within limits, the extra wells do get more oil. There can be waste in drilling *too few* wells, not only in drilling *too many*. The most profitable spacing for the nation, as well as for the operator, is the one that will make the greatest total profit.

It is claimed that you can get the same recovery and more by water flooding or repressuring, or pressure maintenance. These processes do increase recovery. But they do so in close-spaced fields as truly as where the wells are far apart. Wide spacing means that oil has to be moved farther under secondary recovery methods as well as in primary natural yield. That takes more energy, and energy costs money.

Can secondary processes be used as a substitute for closer spacing, and get the same results at less expense? There's the practical question. These great gas injection plants cost money —money by the millions. They cost so much that we hear it said that, of the many great recycling plants which have been installed in distillate fields, not one has yet paid out, or is even sure of paying out.

Waste Energy; Lost Reserves

Wide spacing wastes energy, whether it be primary reservoir energy or the energy you pay for when you force gas or water into the sand in secondary recovery. And this waste is not just peanuts. It is vast. If the wide spacing vogue of the past 20 years has placed the average well even 50 per cent farther from the neighboring wells than the distance that would have yielded greatest profit, at least 10 billion barrels of oil—ten thousand million barrels—has been left underground that could have been produced at a profit in primary recovery. If the same practices continue the ultimate loss in the United States alone could reach several times that figure, and in the world, to hundreds of billions of barrels.

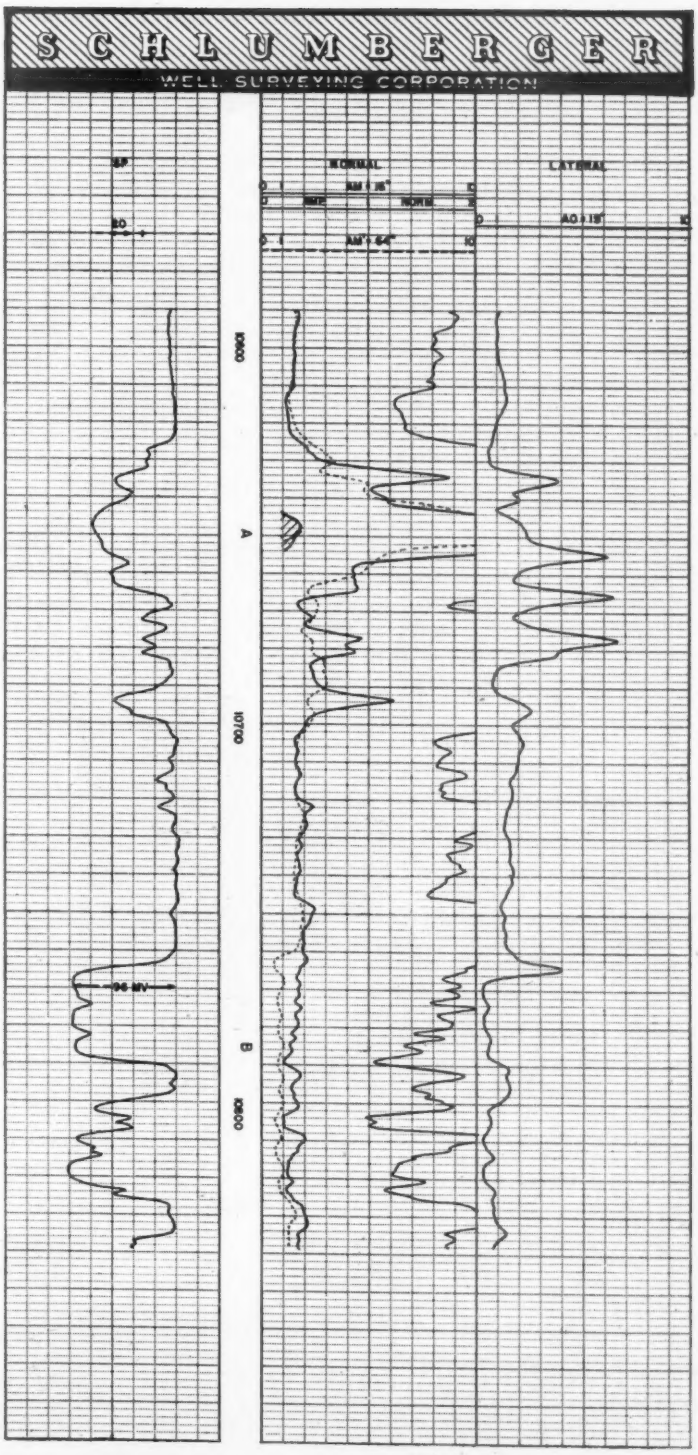
Secondary methods will get some of it. Some of it is forever lost because of too wide spacing. These are our lost reserves. We are still adding to them by the same mistaken practices. Wide spacing is being preached, even in the movie, "Tulsa."

Why have many operators been so well sold on wide spacing? Partly be-

MIOCENE SAND
IN POINTE A LA HACHE FIELD
PLAQUEMINES PARISH, LA.

13

Mud (Baroid):
R_m = 0.92 ohms at BHT
Bit Size: 9⅞"
Spacings: AM = 16"
AM' = 64"
AO = 19'



LOG ANALYSIS

1) Water saturation S

R_o = 0.8 ohm in water sand around B level

The value of 20 ohms given in level A by both the 16" and 64" Normal when corrected will result in R_t = 27 ohms approx.

In level A $S = \sqrt{\frac{0.8}{27}} = 17\%$ approx.

2) Formation water resistivity R_w

$SP = -90 \log_{10} \frac{R_m}{R_w} = -96$ mv.,

thus, R_w = 0.08 ohm BHT

3) Porosity p

$F = \frac{R_o}{R_w} = \frac{0.8}{0.08} = 10$

$p = \sqrt[m]{\frac{1}{F}} = 28\%$ for m = 1.8

CORE ANALYSIS

Porosity	26 to 34%
Permeability	1800 md.

PRODUCTION RESULTS

Perforated	10,669-80 and 10,689-93 with 24 shots
Potential	240 BOPD, 34° API Gas oil ratio 675/1

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HIGH PRESSURE CONNECTIONS IN CLOSE QUARTERS . . .

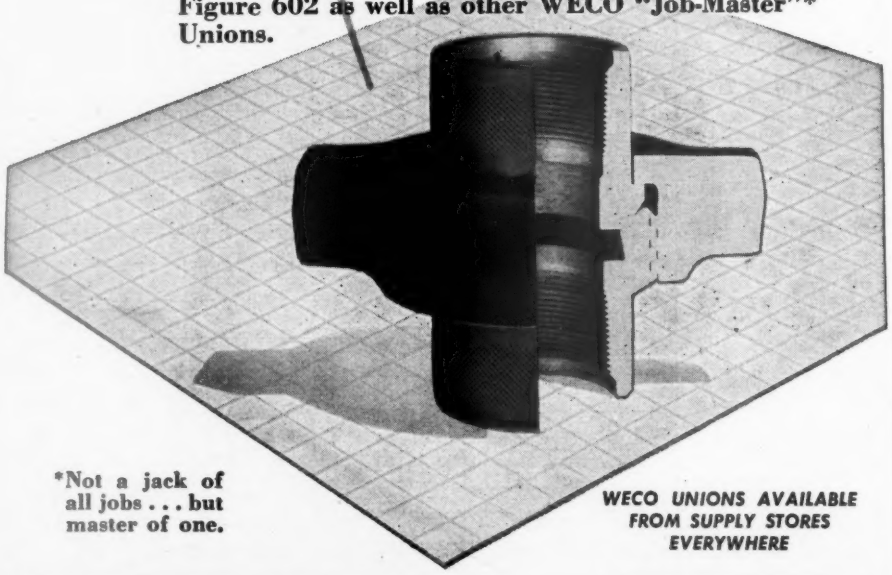
From sub end to sub end . . . from wing nut tip to wing nut tip, WECO Figure 602 Union is a champion in every respect. Designed for compactness, and retaining all the features of strength, speed and easy handling, perfect sealing, fast make-up, Figure 602 is ideal for high pressure connections in close quarters.

Figure 602 Union has forged steel subs with rugged wall sections . . . heavy Acme wing nut threads. The traditional WECO metal-to-metal seal is protected against abrasion and corrosion from line fluids and gases by a replaceable resilient seal ring which has proved capable of withstanding the extremely high pressures of the Oil Industry. With or without the resilient seal ring, Figure 602 gives you a perfect seal.

Figure 602 is ideal for welded installations. The resilient seal ring can be replaced simply by backing-off the wing nut, and the seal renewed without cutting off the sub ends.

Specify this time and space saving champion when making up connections in close quarters. It is available in sizes 1" through 4"; has a cold working pressure of 3000 lbs. per square inch.

ASK YOUR WECO REPRESENTATIVE about Figure 602 as well as other WECO "Job-Master"* Unions.



*Not a jack of all jobs . . . but master of one.

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cause you do get more oil per well, when the wells are far apart. That's an advantage that stays with you, even when the price of oil is low. And partly because theorists have told them they would get just as much oil per acre. That is *not* true. Experience denies it, and the theory is false. You get *less* oil *per acre* in wide-spacing. Where is the error?

The theoretical backing for wide spacing rests on equations of radial flow which demonstrate—and rightly—that *if* you can increase the drainage radius of a well *without* increasing its natural rate of production, it will require little more energy to drain the larger area. *But* the only reason you like to drill them far apart, is that you *do* then get more oil per well. If you could get just as much per well no matter how close you drilled them, every field would look like Spindletop or Signal Hill. You couldn't drill wells close enough together to please you.

But when one admits that the natural rate of flow increases with increasing distance between wells, he blows up the theoretical basis for wide spacing. Take those same equations, and let the rate of flow increase as spacing widens. Now you find that the energy consumed per barrel produced increases in the same proportion—in proportion to the distance between wells. And your total primary recovery of oil drops in inverse ratio if you exhaust the reservoir energy before you have gotten all the oil you could.

Perhaps you don't produce your wells to capacity. The oil moves more slowly to your wells, and uses less energy in getting there. But have you saved it? There is surplus energy in each barrel of oil that comes to your choke against back pressure there. But is anything left of that pressure, or of that "saved" energy, when the oil reaches the stock tank? Not a bit.

Element of Time In Oil Migration

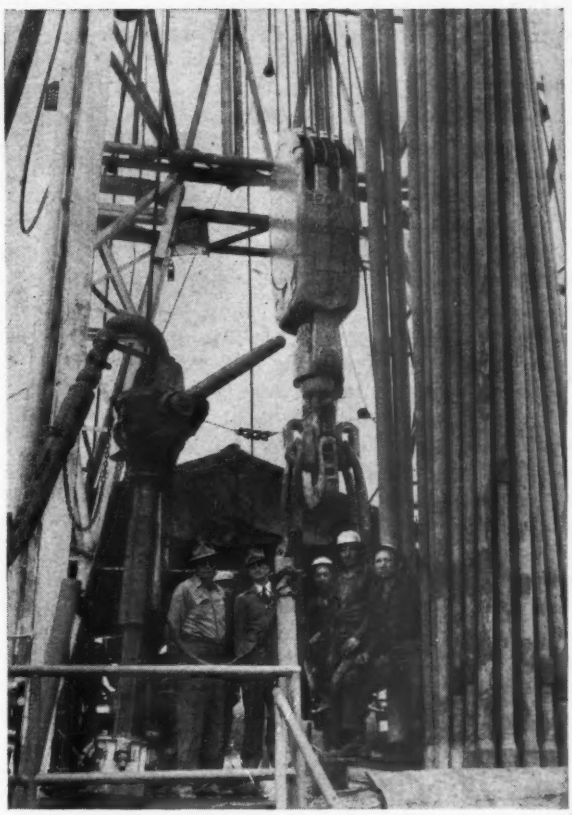
Did you ever figure out how long it will take for oil to reach a well in the center of a 40-acre tract, from the edge of the 40? It's not hard to figure. For example; suppose a well is making 100 bbl a day from 100 ft of sand. That's a pretty good allowable, these days. Oil moves into such a well many times faster than into the average American producing well today. Assume 20 per cent porosity, and 25 per cent shrinkage of the oil between the pay sand and the stock tank. One foot from the center of your well-bore, that oil is moving only three inches an hour. At 330 feet back, if there's no water drive, it's moving not more than 1/6 of an inch per day—5 ft per year. And its average speed from the

"...the *right combination* for portable rig drilling!"

REGAN 36-200

Narrow-Type Traveling Block and Forged Steel Combination Casing Hook

Here is a narrow, compact traveling block, 21⅞" wide, 38" deep with a full 200-ton capacity, ample weight for free falling, *yet only 76 inches in overall height.* Built to rigid Regan standards, the 36-200 combines the best features of all Regan traveling blocks—individual outer race rings for each bearing; dual bearings with individual grease lines for each sheave; heavy rigid sheave plates. All parts far exceed required safety factor. Designed for use with the Regan No. 6 forged, heat-treated alloy steel Combination Hook, it provides a block and hook unit which is only 144 inches in overall height—*four feet shorter than any other block and hook of similar capacity.* Hook has special friction reducing adapter allowing it to smoothly swivel into position at proper angle to traveling block. Ask your Regan representative for full details.



W. H. Black Drilling Co., Inc., of Midland, Texas, use a Regan 36-200 Traveling Block and No. 6 Combination Hook on their Rig No. 1 currently drilling near Snyder, Texas. Left to right: J. H. (Jimmie) Lowe, tool pusher; W. W. Parmley, driller; Marvin A. Weston, Regan representative; P. B. Pace, C. E. Moore and L. D. May, floormen. 12

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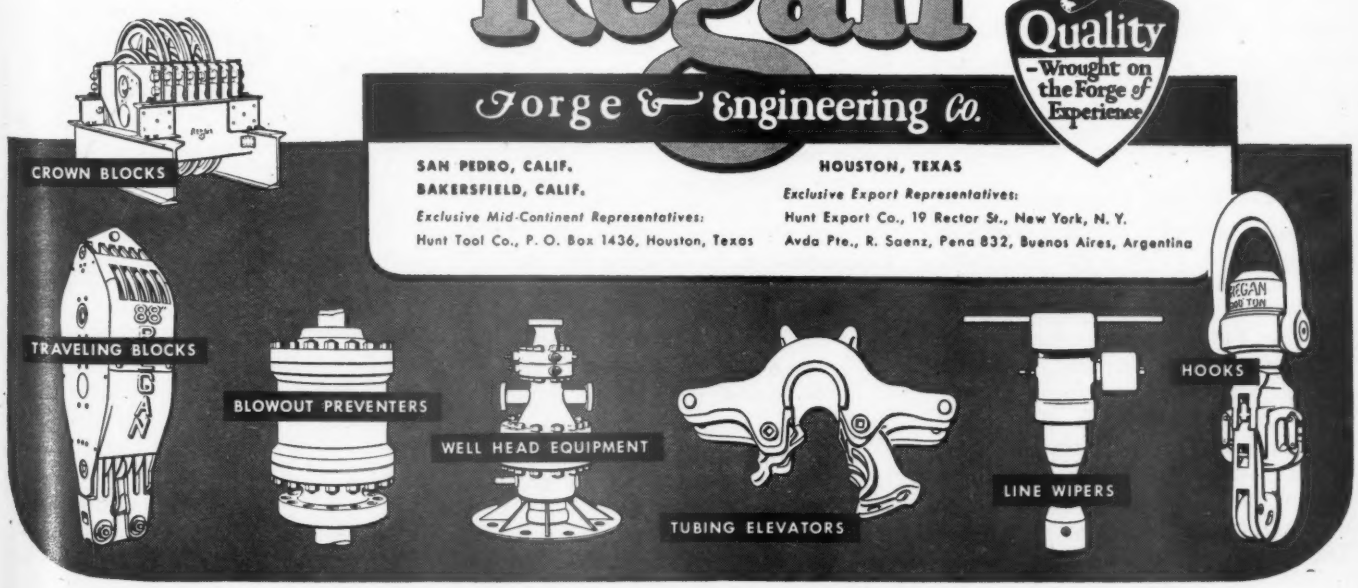

edge of the 40 to the well will be less than that. The journey will take at least 130 years—longer, if the well declines. Have you ever had a well that produced 100 barrels a day for 130 years? With declining rate of flow, 1000 years is nearer the true time requirement for that trip.

Engineers bring to court estimates of primary recovery as low as 15 per cent of oil in place. We should be ashamed to admit such inefficiency. What actually happens in such cases is that we recover perhaps 75 per cent of the oil that was in place in a very few acres close to the well and none at all from the outer acres. It just doesn't have time to get there. And the natural reservoir energy is exhausted before it does.

There are limits, "critical spacing," beyond which closer spacing will be of no avail. There are fields from which practically the last drop of recoverable oil has been obtained. There are economic limits too, for there's a real advantage in the larger recovery per well for wide spaced wells. But up to those limits, more wells do get more total oil. If the extra oil will pay for the extra wells, and then some, they are worth drilling. If it won't, they shouldn't be drilled.

Fortunately, some operators have not fallen for wide spacing propaganda. The common sense of many independents, their reliance on actual experience instead of on erroneous theory, has kept them on the right track. As a result the nation's oil reserves are greater than they would otherwise have been. In California, thanks to an overwhelming mass of experience proving greater recovery —and greater profit—from close spacing, few operators large or small have been sold on the opposite idea. It is said that 80 per cent of the nice increase in California's oil reserves since the war has come from additional drilling in old producing areas.

Enough of that. You didn't expect me to tell you how to get more oil from the fields you find. You want me to tell you where to find them.

Exploratory Provinces

Eight years ago, under the editorship of Dr. A. I. Levorsen, the American Association of Petroleum Geologists published a symposium on Possible Future Oil Provinces of the United States and Canada. Nine great regions were discussed, and 49 subdivisions. The geologists of seven of our local affiliated societies in those regions helped to write the book, and men of three Canadian geological surveys and the U. S. Geological Survey. The emphasis was on areas not yet producing very much oil, if any, at that time.

In those 8 years, substantial new oil reserves have been found in 6 of the 9 regions. Discoveries have been made in 11 of the 49 districts. Some of these will lead to many more, for they have greatly stepped up the pace of exploration there. Examples are the Alberta plains, Cuyama Valley in California, parts of Wyoming and West Texas, and Oklahoma's Anadarko basin. The coastal waters of the Gulf of Mexico, too, have responded to daring and costly exploration; though this has been done under the needless handicap of conflicting claims to title between the nation and the states.

Where will the next great discoveries be made? In any of those nine regions, or in almost any of the old producing districts. This much is certainly safe to say: Known American oil reserves will be greater a year from now if the price of oil remains good, than they will be if it falls. And the same is true for five years from now, or ten.

Five years ago, there were some minor oil and gas fields in the plains of Alberta, east of the great foothills field of Turner Valley. The area was listed like many others as an oil province, inadequately explored, which might have much oil, but was only known to have a little. No one prophesied the gushers of Leduc and Golden Spike.

But the possibility of such fields was seen, by geologists of Imperial Oil, which had produced oil from a reef of Devonian limestone at Norman Wells, a thousand miles northwest. Now they are finding reefs with rich production at many places under the Alberta plains.

Nor did anyone predict, five years ago, that the old Velma field, 35 years old and no great shakes to start with, would surge to brilliant new performance as the leading field in Oklahoma. Chief credit for that goes to Bill Skelly and his staff—faithful supporters of the IPAA. Many another independent has shown the world that he too can find more oil when the price of it provides the money he needs for exploration. When the price is poor, he hires fewer geologists, tests fewer of his own ideas. He drills fewer wells, and finds less oil.

Six years ago the Springer formation had never yet put a drop of oil into Oklahoma pipe lines. It was known to be absent in fully half the state. Yet today it is yielding more oil than any other Oklahoma formation of Pennsylvanian age; and Springer wells possess more of the state's capacity to produce in excess of allowables, than all other sources put together.

And what was known of the Devonian in West Texas a few years ago? Or of the Ellenberger?

Discovery Rate vs. Price

These discoveries, even though recognized in advance as possibilities, could not be predicted with any confidence. They were not foreseen by the good folk in Washington, who long ago lost faith in the resources of this continent. We cannot forecast in detail the discoveries of the next five years: But we know that many will be made. The poorer the price of oil, the fewer discoveries. The better the price, the more discoveries. It is the old, inexorable law of supply and demand.

The one factor which, more than any other, will determine the adequacy of our domestic oil supply in another war if it comes—which God forbid—will be the average price of crude oil between now and then.

A second vital factor is the maintenance of competition. There are 12,000 or 15,000 oil producers in the United States. Every one of them, large or small, is free to act on his own discretion, within his means. Every one of you have had the experience of succeeding in some enterprise which had been rejected by another producer as too risky. It didn't suit his judgment. It did suit yours.

You have seen new companies enter a district where they never had produced before. Seen them start from scratch to gather information, take leases and drill, in competition with companies which had been there for a generation, and had all those data in

Phoenix Fields Rise Again

Old oil wells, once thought to have yielded their last recoverable drop of crude petroleum, are being reactivated as a result of oil industry technical advancements to produce from 25 per cent to 300 per cent of their original recovered petroleum. By flooding the old wells with water under pressure it is estimated that up to 14 billion barrels of additional crude oil can be obtained from now-abandoned sites.

Other recovery methods being used by the industry are vacuum pressure, air and gas injection.

their files already. You have seen the newcomers in the next few years, in some cases, find more oil than the old-timers.

Values of Independent Action

Under socialism, that couldn't happen. Socialism is monopoly — more complete and even less efficient than private monopoly. If our industry were nationalized, all decisions would be funneled through one office in Washington. We'd be short of oil in no time—and forever.

If the government should undertake to develop our tidelands itself, instead of leaving it to private industry, they would surely find only a fraction as much oil, and it would cost the nation more, per barrel.

Those who underrate the undiscovered reserves of North America insist that we must depend largely upon foreign sources for our future oil. They urge, too, that we now develop a vast industry to extract oil from coal and shale, regardless of the cost. That would be depleting our domestic reserves just as truly as taking it from wells. It will be needed sometime. We applaud the experiments with it, now carried on by the U. S. Bureau of Mines.

Every encouragement should be given to Americans to find and produce oil abroad. When Americans make money abroad, all of us benefit at home — just as England for two centuries, by virtue of foreign investments (many of them here in the U.S.) lived better in her islands than she could otherwise have done. She helped us by those investments here. And when Americans develop previously undiscovered resources in other countries, even more than they help us they benefit the people of those countries; of Venezuela, Colombia, Arabia. Although they too seldom are rewarded with affection there, or thanks. Our investors abroad deserve the full support of our government, and its protection of their contracts.

Obviously, the more oil we import for our use, the less we need deplete our resources here at home. If we could be sure of a peaceful world—and we pray that such assurance may yet come to us and to all countries—it would appear to be wise policy for the nation to import much of its needs as long as they can be supplied in that manner more cheaply than at home.

Imports Retard Discovery

Such a policy obviously would retard the rate of discovery here. It would repress the domestic oil industry. And that's *us*. Sometime we shall have to do it. But do we dare to do it now?

Who is sure of peace? And for how long? Where would we have been in the last war if we had been unable to produce our wartime oil requirements here at home? Even nearby Venezuela was completely shut off from us by German submarines. Do you wonder that the Russian Navy is reported to be specializing in submarines?

Need for a Surplus

Before the war, our domestic oil industry was burdened with a surplus capacity that held down the price. And the price was frozen there, at a level that prevented us from making new discoveries as fast as we used up that surplus. But never did a surplus come in so handy. It was essential to victory. It fueled our ships and planes and tanks. We used it up, and came up short of oil after the war. That brought a better price. The better price stimulated discovery, and built up again a small surplus capacity to produce.

As Ernest Thompson has said, the rebuilding of such capacity in excess of current needs is the most vital contribution our industry can make to the national defense. It is still far too small. If another war should come, our surplus producing capacity here at home must be larger than it was at the outbreak of World War II. That goal can be achieved, but only by continuance of a high rate of discovery, and of a good price for oil. Our national safety depends upon it.

Presumably the time will come that for 40 years, to the prophets of gloom, has seemed just 10 years ahead: The time when our domestic oil supplies from wells finally and for good become too small. It hardly seems possible that we can continue for another 40 years to keep up with skyrocketing demand, from domestic wells alone. Because of *your* efficiency, and the competition among you, we have already found by the most conservative estimate at least half of all the oil we have in this country that can be obtained from wells. In the rest of the world, if oil is present in similar abundance in the sediments, perhaps less than 10 per cent has yet been found.

Therefore the time will surely come, here at home, when even the stimulant of higher prices will bring but small result. But you have proven fully, in 1948, that as of now it still bears ample fruit. The surest, the quickest and the cheapest way to reestablish an adequate surplus oil supply at home is to let you fellows find it. Give you the wherewithal, and you will do the job.

The nation *needs* it. More power to you! * * *

Shell Begins Drilling for Oil in Queensland

Queensland, Australia, will soon have a deep test. E. N. Avery, the general manager of the Shell Company of Australia Ltd., has announced that Shell (Queensland) Development Pty. Ltd., commenced drilling a deep test well May 1. It is situated at Morella, 100 miles south Springsure rail head.

Shell began its search for oil in Queensland in 1940. In addition to investigations carried out over the surface of vast areas of Central and Western Queensland by the company's geologists and surveyors, geophysical teams probed beneath the surface for evidence of geological structure. Much of the territory was photographed from the air and then mapped.

The work was interrupted by the war in 1943 but recommenced in 1946. By September 1949, the company had selected the present site for deep test drilling and the preparatory work has now been completed. Water and electricity supplies are available and, in the accommodation provided for the staff, each man has a room to himself.

When the well has been completed Shell will have spent over one million pounds on its search for oil in Queensland.

Avery also said, "The drilling plant and equipment at the site will permit drilling to a depth of 10,000 ft. Whether we do or do not drill to this depth will depend upon a variety of conditions—geological and mechanical and they can only be assessed as the work progresses."

He added, "It is too early to say whether oil is likely or not. We are satisfied we are drilling on the best site in our location but it is still a virgin area as far as oil in commercial quantities is concerned.

"Good use could assuredly be made of any oil discovered but it would be premature at this stage to consider ways and means by which it could be handled and refined. It is a source of great satisfaction that after all the long and arduous work entailed and the great expense involved, we have now reached the drilling stage."

Economic Trends of Contract Drilling in California†

R. A. POWELL*

Abstract

The author discusses the rises in costs during the period 1947-1950 of labor, equipment, and other items making up total cost of oil well drilling. In spite of rising costs, increased efficiency plus competition has reduced the footage cost to the operators. The function of the contractor and his relation to the operator are reviewed.

IT HAS been my distinct privilege for the past three years (1947 to 1950) to be engaged in an industrial adventure that has given me a number of new ideas on certain aspects of business with which I was formerly just vaguely familiar. I am not sure that my analysis and presentation of the things that have excited me in this adventure will be of interest to you, but I am certain that it is good for all of us to indulge in open discussion of our problems, especially if we can free ourselves of inherent bias, and look at our respective situations objectively. I have chosen to speak to you today, therefore, about economic trends of contract drilling, not as an expert economist; not as a drilling expert, but simply as one whose long experience in estimating costs, and balancing income and outgo, has developed a natural inclination to look into the economics of all operations.

Operating Costs

Without further delay now, let us consider some of the cost changes that have taken place within the past three years. There is no question that in any species of enterprise, man is the most important element, and there is no question either that under our system of free enterprise, the lot of the working man has improved steadily and markedly. The lot of our workers has definitely improved in all positions throughout the time under discussion, not only in the matter of remuneration for his services but in the secondary process of providing him safe conditions in which to work. This latter may in the long run be a profitable investment, but to the callous mathematical eye it represents an immediate and in some instances sizable expenditure. Looking at wages specifically, the most important individual in our particular labor category is the driller, and his take home pay has been increased during the three years in question by about 26 per cent. A driller is now paid $20.20 per day before taxes. That is a pretty substantial boost any way you look at it, but it is only a part of the total story.

The cost of workmen's compensation insurance rose some 15.0 per cent to a present manual rate of $6.15 per $100.00 of payroll because of the increased cost of medical, surgical, and hospital services. Federal Old Age Benefit contributions rose 50 per cent from 1 per cent to 1½ per cent of the first $3,000.00 of earnings. So-called "fringe" items, during this same period, became more and more costly. Employee life insurance jumped 14 per cent. There is literally nothing in the entire gamut of what might be termed employee protection and benefits that hasn't climbed steadily cost-wise during the past three years, and yet, instead of reducing these benefits to compensate for increasing cost, the tendency of industry in general, and our own in particular, has been to enlarge them and to widen in every possible way the scope of employee protection. Labor and supervision per crew day has increased from $329.00 to $430.00 in 1950, or an overall increase of 30 per cent.

Rig Supplies

Next, let us examine the status of operating equipment and consumable goods or whatever you choose to call the tools and supplies that are used in contract drilling. They consist of bits, hole openers, core heads, soft rope, wire lines, fuel, lubricating oils and greases, and a miscellany of small hand tools and other items too numerous to list here. By the way, it may be a trifle aside from the question, but if some of you operating men could tell me why so many crescent wrenches, derrick hatchets, shovels and hand saws are needed on every drilling rig, I would sure be grateful for the information.

Any way, some of these hand tools have gone up 100 per cent in price during the last three years, and just to convey the general idea, a few of the other items that have been skyrocketing are drilling bits, which have risen 23 per cent—from $181.00 to $222.00 for a 12¼ in. bit, soft rope up 20 per cent from $0.44 to $0.53 per pound, and wire lines up 46 per cent from $0.26 to $0.38 per foot. I might say here, also, that the increased value of gas fuel has been one of the deciding factors in the adoption of power rigs, and the reduced employment of steam. There is no apparent leveling out of prices up to the moment and what might happen during the next three years would be very difficult to predict. The unit cost of rig supplies has, in my opinion, increased an average of 17 per cent.

Transportation

There seems to be no end to the story. The cost of trucks, cranes, etc., used for moving in, rigging up, dismantling, and moving out, has increased. The total cost of moving a rig today as compared with the same cost in 1947 is not easy to determine, because the same set of conditions seldom prevails in two separate projects. The main factors influencing cost are accessibility of location, spud date, distance of move, and weather conditions. (The spud date is important because wages, as you know, increase on Saturday, and increase still more on Sunday.) These are more or less direct charges of which we feel the impact at once, but there are others, what we might call concealed items, that can cause us just as much distress in their subtle way. The cost of transportation has increased 10 per cent in my opinion.

Depreciation

One of these is depreciation; the number one bugaboo of the contract drilling business — and most other businesses, too. Although a large item of cost, its basis is indeterminate and in many respects, illogical, but there doesn't seem to be much we can do about it. It wasn't much of a problem prior to the enactment of the Federal Income Tax Law, but it has certainly made up in the meantime for the slow start. A thousand experts have tried to define the term "depreciation" and its theoretical and practical application; that is, in an accounting sense, but it still is a doubtful quantity. My own pet definition is that depreciation is cost plus maintenance, less salvage recovery, and is due to use, wear and tear, physical deterioration, obsolescence, inadequacy, and demand.

The depreciation cost is, of course, distributed over the useful life of the equipment or machine to which it is to be applied, and there is some indi-

†Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, California, May 11 and 12, 1950.

*Santa Fe Drilling Company, Santa Fe Springs, California.

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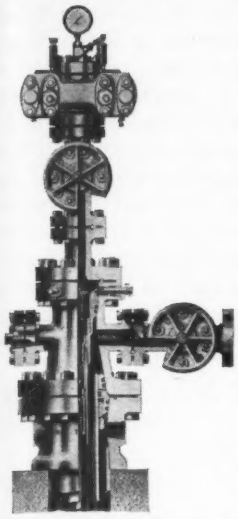

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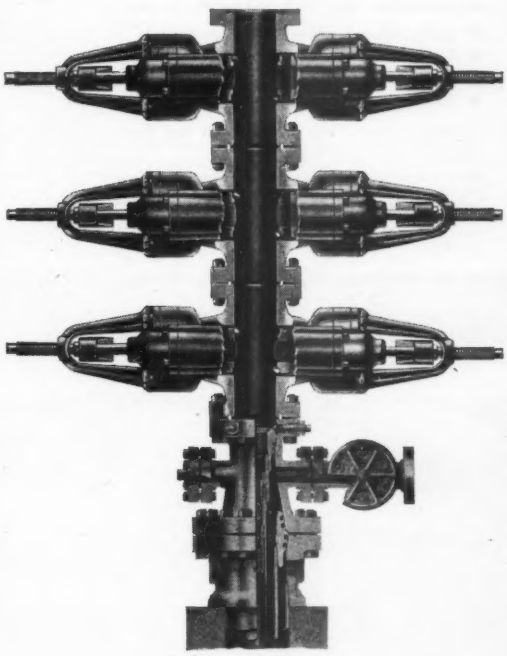

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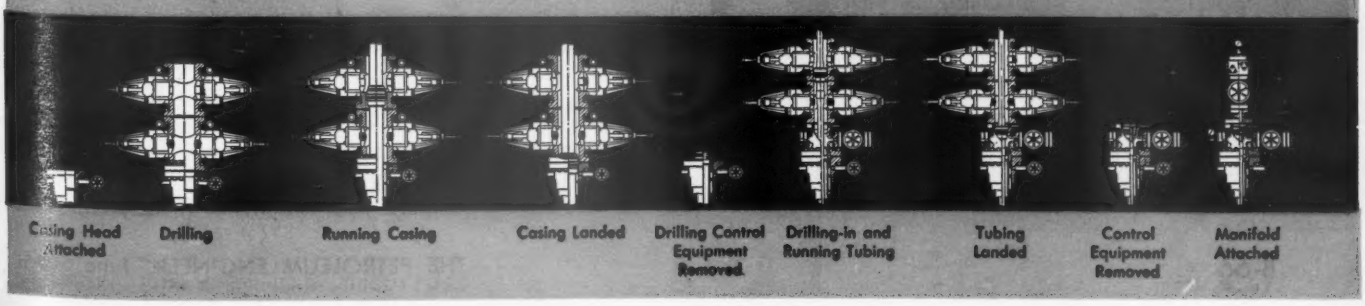

cation of its indefiniteness in the fact that even accountants are rarely in agreement as to the figure in any given instance. Incidentally, the Internal Revenue Act, as it now stands, does not take into consideration the cost of replacement, and makes no adjustment for the continued rise in prices of replacement items, both of which are certainly pertinent factors in any measure of depreciation.

Supervision and Overhead

Another considerable contributor to the total cost of a drilling project is what we call "Supervision and Overhead," and here again a large increase is to be noted in the past three years. It approximates 25 per cent, but the accurate amount depends largely on the number of wells being drilled, and their location. Obviously, if a sizable number of wells are being drilled within a comparatively confined area, or in locations that are in close proximity to the contractor's headquarters, the cost of operation in many phases, including supervision and overhead, may be decidedly reduced. In this connection, I might point out that at least 25 per cent of the latter cost is attributable to the preparation of records and reports, demanded by a diversity of governmental agencies and authorities, and ultimately used to fix the various forms of taxation that make life so rugged in our business nowadays. It is amazing that in spite of the multiple and manifold taxes already imposed on us, the State and Federal bureaucrats can still think up new ones.

The breakdown of the contractor's time and cost estimates in the drilling of any well is based on the following well recognized operational intervals: Move in; rig up; through surface casing; through oil string; drill out; day work; dismantle, and move out.

The total daily cost of operating a drilling rig was $983.00 per day in 1947. In 1950 the same rig costs $1162.00 per day or an overall increase of 18 per cent.

Summary

While the various items entering into the drilling costs have increased in the manner described above, the increasing efficiency in drilling has kept the cost per foot from increasing in the same proportion.

In the table below is a comparison of the cost per foot and the cost per day of wells drilled in 1947 and wells drilled in the last quarter of 1949 and the first quarter of 1950. This table is based on average experience of bottom hole contracts of similar depths.

	1947			1949-50		
	Cost per foot	Per cent	Cost per day	Cost per foot	Per cent	Cost per day
Labor and supervision	$2.29	34	$329.52	$2.14	37	$ 430.40
Supplies	.40	6	57.85	.35	6	65.60
Maintenance of tools	1.01	15	147.53	.64	11	127.38
Bits	.89	13	124.35	.87	15	172.30
Drilling fluids	.41	6	59.94	.29	5	58.12
Trucking and services	.62	9	89.34	.58	10	118.14
Site preparation	.13	2	23.33	.18	3	34.86
Depreciation, overhead and miscellaneous	.98	15	151.26	.76	13	155.53
	$6.73		$983.12	$5.81		$1,162.33

Footage Rate Costs

It is significant that about 72 per cent of all drilling costs are chargeable to time. The drilling contractor must in consequence budget his time with the utmost care, and never relax his efforts to remove every impediment to the drilling process. From an analysis of 400 development wells, drilled during the three-year period under consideration, the actual "making hole" time has been decreased by 16 per cent. I might say that I made some effort to determine whether or not completion time had decreased during the three-year interval we are discussing, but I found that completion practice varied so much with sub-surface conditions that it was utterly impossible to strike anything like a comparable relationship. Thus, we have what seems to be a pronounced paradox: While the cost of labor, equipment, and most other involved components of oil well drilling have continued to increase over the past three years, *the footage cost to the operator has declined*. In one field the footage price has declined from $7.65 per foot to $5.25 per foot. In another field, the footage price has declined from $6.35 in 1947 to $5.45 per foot in 1950.

This, in my opinion, is due to the following: Increased knowhow of crew members, (most important); improved supervision; new equipment; new processes; new devices, and new techniques.

In order that a contractor may hold his efficient, well trained, and experienced crews, there must be a continuity of work. Conversely, in order to secure continuous work the contractor must constantly improve the skill of his men and the quality of supervision.

From our own experiences, it looks as if the trend at the

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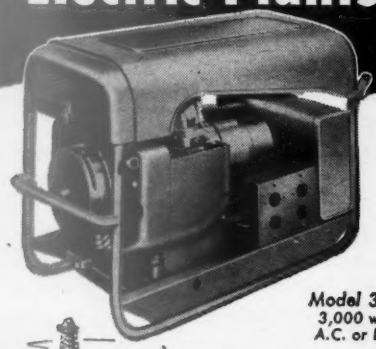

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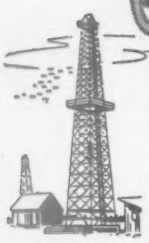

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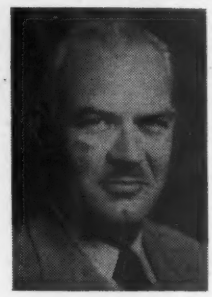


R. A. Powell was graduated by Oregon State College, school of business administration, class of 1923. After having an interest in a trucking and produce brokerage business, he moved to Long Beach, California, in 1925 and built and operated a service station which was disposed of in 1927.

He held a position with the Union Oil Company of California from 1927 until February 1, 1947, in the comptroller's office working first at the Los Angeles refinery, then at Santa Fe Springs field office, Bakersfield field office, and head office in Los Angeles.

In February, 1947 the Santa Fe Drilling Company was formed and Powell has been associated with it since that time in the capacity of secretary and treasurer of the corporation.

moment is more and more toward fuller service on the part of the contractor. The latter is now being looked to for such services as road building, site preparation, sump digging, and for the furnishing of blowout prevention equipment, conductor pipe, fuel storage, fuel, casing and tubing tools, and all manner of incidentals.

Contractor's Position

Now having discussed increased operating costs and what we have done to offset them, we are in a position to discuss rationally the relation between the contractor and the operator—to determine, in other words, what the contractor has done and can do to keep well drilling costs at a reasonable level. After all, the contractor has nothing to offer the operator if he can't function as well as the operator can himself, at a lesser cost per foot, or at the same cost per foot, ridding him coincidentally of all the worries that normally go with the drilling job—including maintenance and accounting for a large inventory. It is evident that operators generally believe in the contract system for a majority of the wells drilled in California are the work of contractors, and the national proportion is even higher.

Services Offered

It seems obvious, and again may I remind you that I am speaking from my own experience, that the drilling of oil wells under contract should be attractive to operators for a number of reasons. To begin with, the contractor is a specialist whose entire time, thought, effort, and personnel are devoted to a single purpose. He is bound, I think, through concentration and selective application, to become especially expert in all phases of his business. He has greater freedom of action, and is constricted only by the terms of his contractual agreement. Consequently, operational problems are tackled—and solved—right at the well, and the process of making decisions is certainly somewhat less complex.

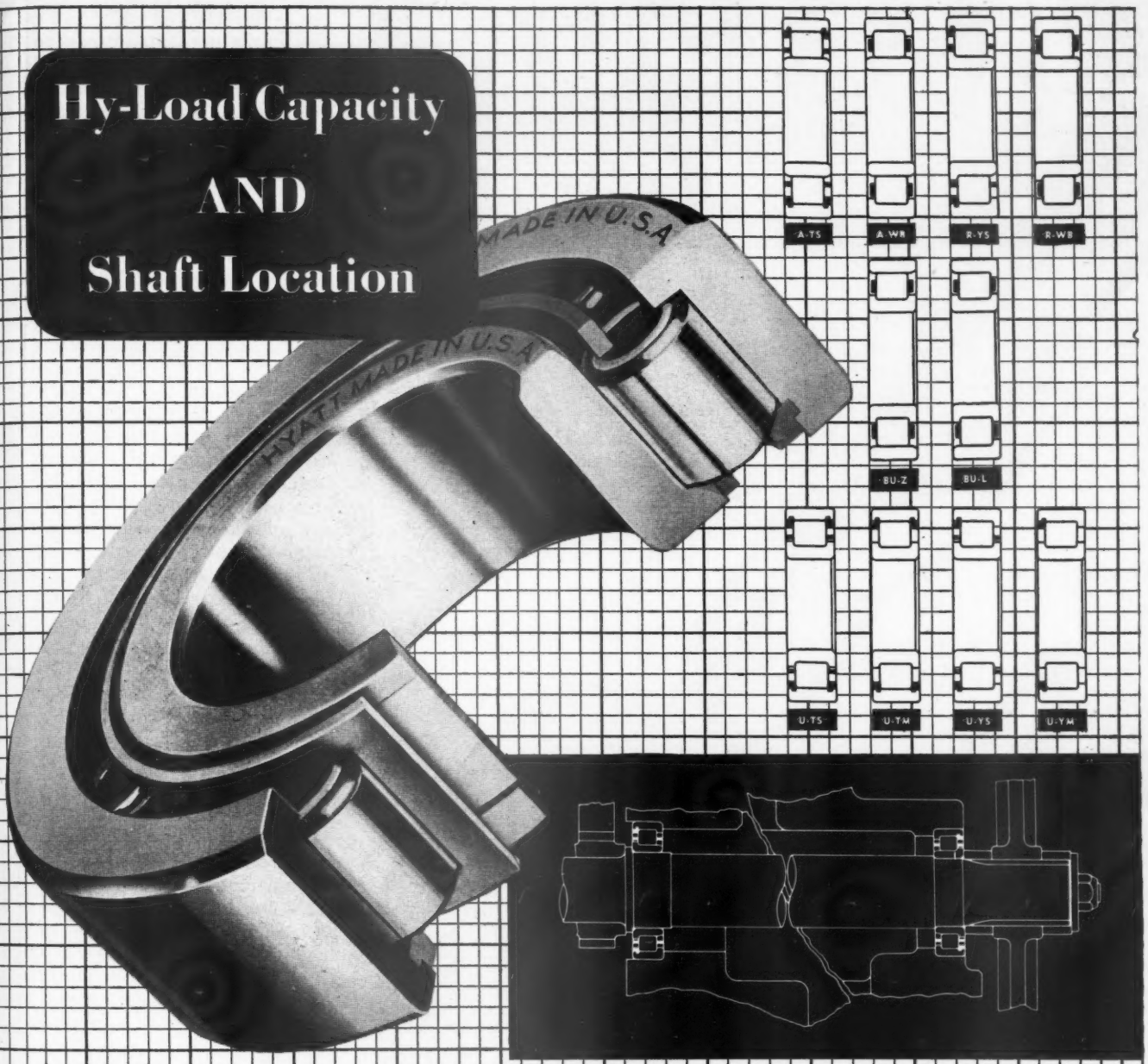
A number of oil companies and large operators contract all well drilling; some contract nearly all; and a few contract their wells only at time of peak activity and heavy drilling schedules. It is my belief that taxwise operators can make good use of drilling contractors to increase or decrease exploration and development expenditures, as the occasion demands. There is plenty of justification for a high rate of drilling in the rapidly growing demand for petroleum and its products, and we can certainly not rest with any sense of security until we have sufficient proven reserves to take care of any and all national emergencies.

One of the best arguments for the contractor is his flexibility. He can distribute his equipment and crews quickly in many directions and for many operators at the same time, the process being limited only by the number of drilling units under his control. The oil operator, on the other hand, is subject most of the time to a widely fluctuating demand, and must equip himself to take care of the peak situation. Thus, he must of necessity have at other times a varying inventory of idle equipment, and that is not good. The contractor is, of course, also subject to fluctuating demand, but, not being confined either territorially or constitutionally, is in a better position to keep his rigs active than is the private operator. By the same token, the operator will find it profitable to engage a contractor because over a period of time the latter's footage cost is bound to be lower for the reason that the operator pays only for active time and is not obliged to pay his crews during time of inactivity.

Supply and Demand

I have noticed, as I guess most of you gentlemen also have, that when there is more efficient drilling equipment around than the industry needs to drill its wells, intense competition results and drilling prices go down. During the past three years we have experienced the entire scope of conditions from an urgent need for drilling

Hy-Load Capacity AND Shaft Location



The cut-away bearing illustrated is an "R-YS" type Hyatt Hy-Load Bearing. It not only provides the high radial capacity of a cylindrical roller bearing but when mounted in pairs, opposed as shown in the drawing above, will also locate shafts.

In the Hyatt Hy-Load line of cylindrical roller bearings there are ten different types, each designed to fulfill specific application needs. Of these ten types, four are made with separable inner races, two with separable outer races and four are non-separable, thus permitting wide flexibility in machine design and assembly procedures. A wide range of sizes are made in every type.

With this large selection of bearing types and sizes from which to choose, a designer can find a Hy-Load Bearing to fit almost any application need.

• • •

Full information about Hyatt Hy-Load Roller Bearings is contained in our Catalog 547 . . . a complete engineering guide to radial bearing selection and use. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

AXELSON
FIRST CHOICE

Axelson Deep Well Plunger Pumps deliver more oil at less lifting cost with less downtime. There is an Axelson Deep Well Plunger Pump for every specific well condition. For longer pump life, order Axelson service-proved Deep Well Plunger Pumps.

Axelson Duax Pump Liners are duty-designed for extremely difficult corrosive and abrasive conditions. Axelson also produces regular and hardened cast iron Liners for satisfactory service under varying well conditions.

WRITE FOR BULLETIN on Sucker Rods and Couplings, Pump Liners, Pump Assemblies, Balls and Seats, specific Deep Well Pump Assemblies, Long Stroke Pumping Units, Pumping Accessories.

AXELSON PETROLEUM PRODUCTION EQUIPMENT

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

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rigs to the prevailing excess of them. While the rigs were in demand, new and improved equipment was developed and purchased. Now that we are in a slump occasioned by too much equipment or too little drilling, everything has inclined to revert to the status quo. Genius is stifled and a lot of drilling equipment is being disposed of, or is gradually depreciating into that lamentable state we term "obsolescence." That is neither good for the operators nor the contractors.

Conclusions

Summing up, it seems to me that it is time for all of us to quit looking on contract drilling as a sort of "delicate baby" industry that needs a lot of coddling to keep it alive. If we haven't grown up now, it is time we had. We are a responsible segment of the oil business, not a bastard offshoot, and all we need do to hold our proper place in the scheme of things is to conduct ourselves in a businesslike way, remembering that the economics of contract drilling is much the same as the economics of any industry. It is simply a matter of producing results in the most efficient way at the lowest possible cost.

I have tried to show in this presentation that in the face of increasing labor and equipment costs, we are still managing to reduce the footage price to our clients, but I would like to say in addition that we stand a good chance of losing the gains we have made if we remain idly and quietly by while an army of irresponsible bureaucrats pyramid our already overheavy tax burden to unbearable proportions.

In conclusion, the drilling contractors have, I am sure by this time, demonstrated that they are in the main thoroughly responsible and reliable. The proportion of wells drilled under contract is pretty convincing evidence that the operators — both large and small — recognize this fact. If, therefore, we are to continue to enjoy this patronage, and if we are to sustain the efficiency we have already achieved, we must at all times not only strive for the very best in mechanical performance and technical knowhow, but we must at the same time keep ourselves constantly apprised of cost trends and their prospective effects on ultimate footage rates.

* * *

People do not always fully realize the astonishing situation that British companies only produce 12.7 per cent of the world's oil, and yet handle 50 per cent of the world's trade in oil, according to H. T. N. Gaitskell, Minister of Fuel and Power, Britain.

NEWS

Indiana Oil Production Up 24 Per Cent In 1949

Nine million seven hundred and thirty-four barrels of oil were produced in Indiana last year, an increase of 24 per cent over last year's production. Mississippian rocks are still producing the majority of the oil, Pennsylvanian and Devonian beds ranking in order. New production in Sullivan and Vigo counties, however, has raised the total amount of Devonian oil. A small amount of oil is being produced from the old Trenton fields of northeastern Indiana.

A total of 66 discoveries were made during the year, including 27 new fields, 15 extensions of old fields, and 24 new producing zones. Total initial production of new oil was about 44,000 bbl daily, based upon reported figures for discovery wells. About 26,000 Mcf of gas, daily open flow, was discovered during the year. Footage drilled during the year was 2,352,900 ft. Completed wells reached a new high figure of 1288, with 494 field oil wells, 358 field dry holes, 27 wildcat discovery wells, 24 discovery wells of new pay zones, 15 extensions to old fields, and 369 wildcat dry holes.

Alabama Operators Denied 10-Acre Spacing Request

The Alabama Oil and Gas Board recently denied an application for 10-acre spacing of wells in the East Gilbertson field of Choctaw County. Present spacing is in 40-acre units. One modification was made in spacing requirements; in the near future wells must be situated not more than 200 ft from the center of a 40-acre unit. Operators had previously been allowed to move as much as 330 ft from the center.

Texas Eastern Transmission Forms Production Company

Officials of Texas Eastern Transmission Corporation have announced the formation of a wholly-owned subsidiary company, Texas Eastern Production Corporation, to engage in exploration for and production of oil and gas.

Primary purpose of the new company, a Delaware corporation, will be to explore for natural gas reserves in connection with its parent company's transcontinental Big Inch natural gas pipe line system, it was announced.

Texas Eastern Production will operate generally in the Southwestern states and will be staffed originally with the same personnel employed by the Transmission company.

Over 12,000,000 feet of
Tubing Surveyed
for CORROSION
with the OTIS
TUBING CALIPER
without killing the well
or pulling the string for
surface inspection
Thousands of barrels of oil are lost annually due to leaks caused by internal corrosion in the tubing and well-head fittings. Wells in highly-corrosive areas have been known to collapse entirely, resulting in expensive salvaging operations and a costly loss of production. It's significant that every year, more and more operators are obtaining surveys of recently-completed wells in order to have a comparison with later surveys to determine the rate and extent of internal tubing corrosion. Otis Caliper Crews have surveyed more than 12,000,000 feet of tubing—under pressure, without killing the wells or pulling the strings—and, when necessary, immediately furnished at the well-sites a preliminary analysis of severely corroded joints. Contact the Otis office nearest you for detailed information on Otis Tubing Caliper services, and a sample "Report of Tubing Corrosion Survey" and a copy of "Foundation for Failure," a new folder on tubing corrosion. Remember, too, that the entire Otis organization and its staff of pressure control engineers are always available for expert consultation at no obligation. We urge you to use the experience we've gained in more than two decades of specialized oil well service work—under pressure.
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NEW IBERIA, La. • HOUMA, La. • BROOKHAVEN, Miss. • LOS ANGELES • BOLIVAR, N. Y. • CARACAS, Venezuela

NEWS

Elect API Officers

At the final session of the meeting of the Eastern district of the American Petroleum Institute's Division of Production in Cleveland, Ohio, K. C. Cottingham, Ohio Fuel Gas Company, Columbus, was elected district chairman for 1950-51.

He succeeds J. E. Schaefer, East Ohio Gas Company, Cleveland, who was named chairman of the advisory committee, succeeding S. M. Vockel, Waverly Oil Works, Pittsburgh, Pennsylvania. Jack Cashell, Preston Oil Company, Columbus, was elected secretary-treasurer.

District vice chairman elected at the meeting's final session were: Paul G. Benedum, Hiawatha Oil Company, Pittsburgh; R. L. Bird, Jr., Columbian Carbon Company, Charleston, West Virginia; H. R. Brankstone, Gulf Oil Corporation, Pittsburgh; R. W. French, Sohio Petroleum Company, Cleveland, Ohio; John T. Galey, independent producer, Pittsburgh; Earl G. Hartman, Gordon Drilling Company, Mt. Pleasant, Michigan; E. T. Heck, Quaker State Oil Refining Company, Bradford, Pennsylvania, and E. J. Straub, Equitable Gas Company, Pittsburgh.

Regulate Two Fields As One

The Texas Railroad Commission will regulate two of Scurry County, Texas' oil fields as a single field. They are North Snyder and Kelly fields. A new set of rules for operating the two fields as a single unit will be prepared, which will provide for 40-acre well spacing in North Snyder-Kelly.

Three other Canyon Reef fields—Diamond M and Sharon Ridge in Scurry, and Cogdell in Kent County will continue as separate fields.

German Crude Output Up

Despite high production costs, German crude oil output is rising steadily, the German American Petroleum Company stated recently. Western Germany now produces about one-third of the crude oil the country requires, although exorbitant product costs are retarding full development of the local possibilities.

The present costs of a ton of imported crude oil is about $20 or 85 marks, whereas the price of a ton of German crude oil varies between 150 to 160 marks.

Observers in Germany, however, expect production to rise from 635,000 tons in 1948 to 1,090,000 tons in 1949-1950. By 1952-53 they believe production will have risen to 1,470,000 tons. The center of production in Germany is shifting from the Lower Saxony fields in the Hanover region to the Emsland fields, which are becoming more and more active.

Members of American Petroleum Institute, Division of Production,

C. W. Evelyn, Jr.

Establishes Casper Office

The British-American Oil Producing Company will establish a production and engineering department office in Casper, Wyoming. This office will have supervision of all the operations of this department in Montana, Colorado, Wyoming, and Nebraska. Mailing address is P.O. Box 620, Casper.

The following personnel are appointed to supervise the operations in this Northwestern district: C. W. Evelyn, Jr., district superintendent, reporting to W. W. Moore, general superintendent, Tulsa, Oklahoma; H. C. Gleason, district engineer, and Jay Sanderson, district clerk, reporting to the district superintendent.

M. T. Johnston, Riverton, Wyoming, field superintendent of Steamboat and Pilot Butte fields, and W. A. Day, Cut Bank, Montana, field foreman of the Cut Bank field, will both report to the district superintendent.

C. W. Evelyn became affiliated with the British-American in 1948. Prior to that time he was affiliated with Frontier Drilling Company in Denver, Colorado. A native Oklahoman, Evelyn was graduated from the University of Arkansas, with a degree in electrical engineering.

Aramco Forms Rome Office

Aramco Overseas Company, a subsidiary of the Arabian American Oil Company, is planning to establish an office in Rome, Italy, W. F. Moore, president of the Arabian American Company, has announced.

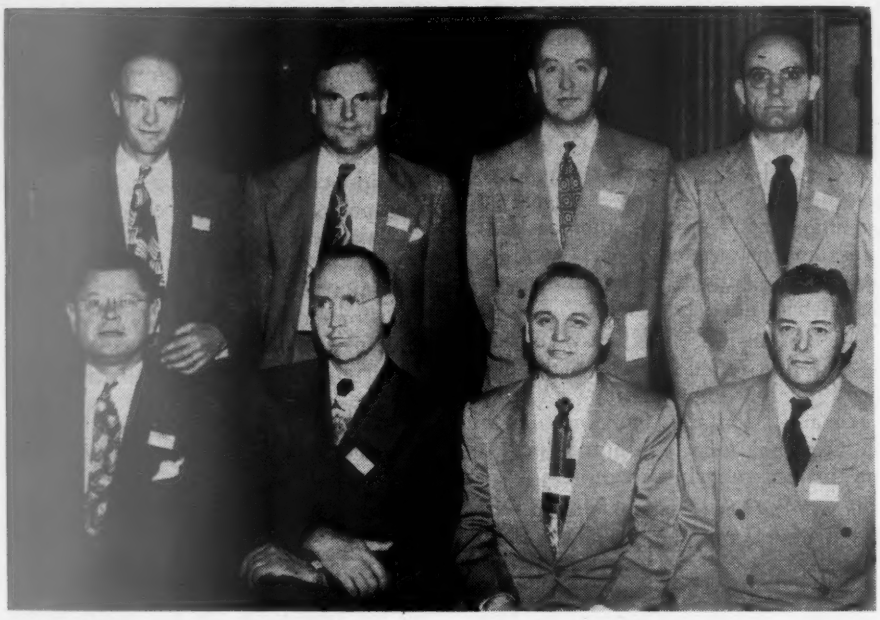
This new office will be used primarily as the European engineering headquarters and for recruiting Italians for employment in Saudi Arabia and for the purchasing of equipment, materials, and supplies for soft currencies.

R. S. Fowler, vice president of Aramco will be in charge of the Rome office.

Colon Venezuelan Output

The Colon Development Company Ltd. produced 336,441 bbl of crude oil in Venezuela for the four weeks ending May 1, 1950. April's total was 393,055, bbl, produced in the five weeks ending April 3.

Eastern Division, banquet at Hotel Cleveland, at spring meeting.



Pacific Coast API Officers. New officers of the Pacific Coast district of the American Petroleum Institute, Division of Production, are: Standing, D. B. Priest, vice chairman, Coastal district; W. M. Lyles, vice chairman, Coalinga-Kettleman district; John Isaacs, arrangements chairman, spring meeting; H. F. Dangberg, vice chairman, Los Angeles Basin district. Seated, C. T. Reichert, treasurer, Pacific Coast district; M. B. Standing, vice chairman, advisory committee; E. C. Babson, chairman; Pacific Coast, and J. P. Shea, vice chairman, San Joaquin Valley.

Saudi Arabian Output Drops 12 Per Cent

Crude oil production in Saudi Arabia is still running 12 per cent below production in the first 4 months of 1950, according to figures released by the Arabian American Oil Company. Figures showed that production was also running 12 per cent below that of 1949 at the end of the first 3 months of this year.

During the month of April Saudi Arabian output amounted to 13,968,335 bbl, or an average of 465,611 bbl per calendar day, off 11.1 per cent from the same month last year. In March production was 12,575,608 bbl.

Exploration Activities Dip In New York During 1949

Total production of oil in New York in 1949 is estimated at 4,216,300 bbl. According to pipe line runs, the amount is 4,216,300 bbl, however this does not include oil transported by tank trucks and oil utilized in the field. The approximate figure shows a decrease of 7 per cent from the 1948 production. There were 875 field wells drilled last year, an approximate decrease of 100 per cent under 1948.

The output of gas for 1949 is estimated at about 3½ billion cubic feet, compared with 4½ billion cubic feet produced in 1948.

Nineteen Oriskany wells were drilled in 1949, resulting in 10 completions, 4 storage wells, 4 wells still drilling, and one well shut down. Of these, 12 were wildcats, and 3 were extension wells. Only a few wells were reported drilling in the Medina.

The most important completion, geologically speaking, was the Clarence Lobdell No. 1 in Chenango County. This penetrated several noncommercial gas horizons and reached a total depth of 5701 ft. Exploration for new producing provinces in New York State showed a decrease from 1948, however, increased wildcatting is expected for 1950.

Illinois Basin Analyzed

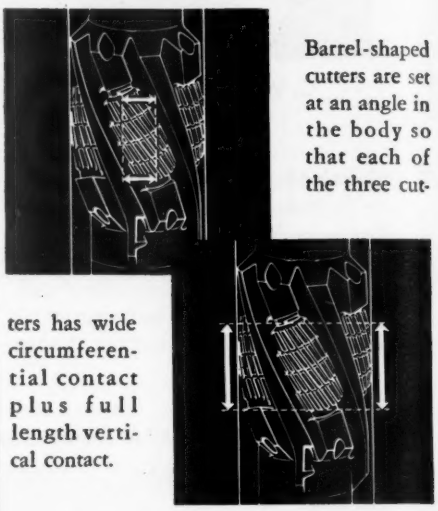
The Illinois Department of Registration and Education, State Geological Survey division, has issued two new publications. *Circular 160*, written by L. E. Workman, D. H. Swann, and Elwood Atherton, is a summary of stratigraphy shown in geological cross-section of Illinois Basin. It contains 18 pages.

Geologic Cross-Section of Illinois Basin, was prepared cooperatively with Illinois Geological Society and Geological Names and Correlations Commission of the American Association of Petroleum Geologists.

Available from the Illinois State Geological Survey, Urbana, Illinois, the circular is free, and the Cross-Section is $1 plus a 6-cent mailing charge for folded copy, and 20 cents if rolled in tube.

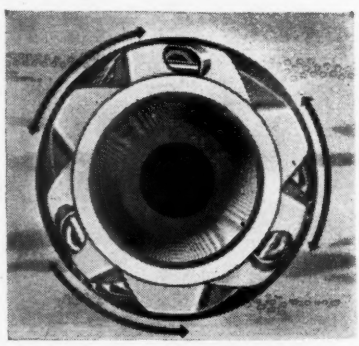
Special Security Reamer for Drill String Stabilization

A new Reamer-Stabilizer especially designed for West Texas fields has been recently developed by Security Engineering Co., Inc. Run between drill collars, this rugged tool eliminates drill stem whip and rock bit gyration or walking, while producing clean, full gage hole.



Barrel-shaped cutters are set at an angle in the body so that each of the three cutters has wide circumferential contact plus full length vertical contact.

When this tool is run, more weight can be applied to the bit to make hole faster because the Security Reamer-Stabilizer acts as a large roller bearing. Full barrel-shaped cutters provide more than enough side wall bearing surface to insure perfect drill string stabilization.



Top view of the reamer body indicates the ruggedness of the tool that permits continuous drill string stabilization under the most severe drilling conditions. Note how cutters contact the formation along an arc of the circle representing the full gage hole, insuring a "bearing-like" action combined with efficient shearing, cleaning action.

Security

ONE OF THE DRESSER INDUSTRIES

Stabilize YOUR DRILL STRING

WITH THE SECURITY REAMER-STABILIZER

- **INCREASE DRILLING WEIGHTS**
- **ELIMINATE DRILL PIPE WHIP**
- **MAKE FULL GAGE HOLE**
- **ELIMINATE BIT WOBBLE**

When the new Security Reamer-Stabilizer is run between drill collars, it not only insures clean full gage hole, but provides unexcelled drill string stabilization. With three barrel-shaped cutters contacting over a third of the wall circumference at all times, this new tool acts as a large roller bearing, absorbing and transmitting to the formation all forces tending to start drill stem whip and rock bit gyration.

The result of running the Security Reamer-Stabilizer is a smooth drilling string to which weight may be added *without* the usual undesirable effects. Drilling can proceed at a faster rate and the time for the entire drilling operation is reduced appreciably.

LOOK AT THESE NEW FEATURES

- **Extra rugged body sections throughout.**
- **Heavy ribs between cutters give maximum strength in torque and bending.**
- **Barrel-shaped cutters provide proper bearing surfaces for efficient stabilization.**
- **Open pockets and directed return circulation keep cutters clean.**
- **Cutters retained in body by exclusive locking device.**

Ask your Security Field Representative about this new Reamer-Stabilizer.

Security

HOLE OPENER

ROCK BITS • CORING BITS • REAMERS • CASING SCRAPERS • SECURALOY

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WHAT'S DOING IN DRILLING

Cities Service Drills Six Wells In Kansas

Cities Service Oil Company (Delaware) recently completed six oil and gas wells in Kansas. Completion of its Hunt gas well in Seward County for 12,100,000 cu ft provides another significant gasser in this area.

Five Kansas wells were completed for a total of 2126 bbl of initial, or at per-well average of 425 bbl. Largest was Lorenz No. 2 in the Bartholomew pool of Sedgwick County, good for 1748 bbl, the largest well for the pool to date. In the Paradise Creek pool of Rooks County, Hilgers A No. 6 was completed for an initial of 249 bbl of oil daily.

Two small producers in the Bemis pool of Ellis County and one in Butler County, brought the total initial of Cities Service completions to 2126 bbl daily.

Borden Pool Extended

A half mile south extension has been completed to Canyon reef lime production on the west side of the North Vincent area of Borden County, Texas. Castlemen, O'Neill, et al have added the extension with the completion of their No. 1-B T. L. Griffin, completed for a calculated daily potential of 364 bbl of 42 gravity oil through ¼-in. choke and open hole from 7014-28 ft. Potential was based on an actual 12-hr flow of 182 bbl, with gas-oil ratio of 1265-1.

The extension is half a mile south of the same operator's No. 1-A Griffin, recently completed one mile west extension to the pool.

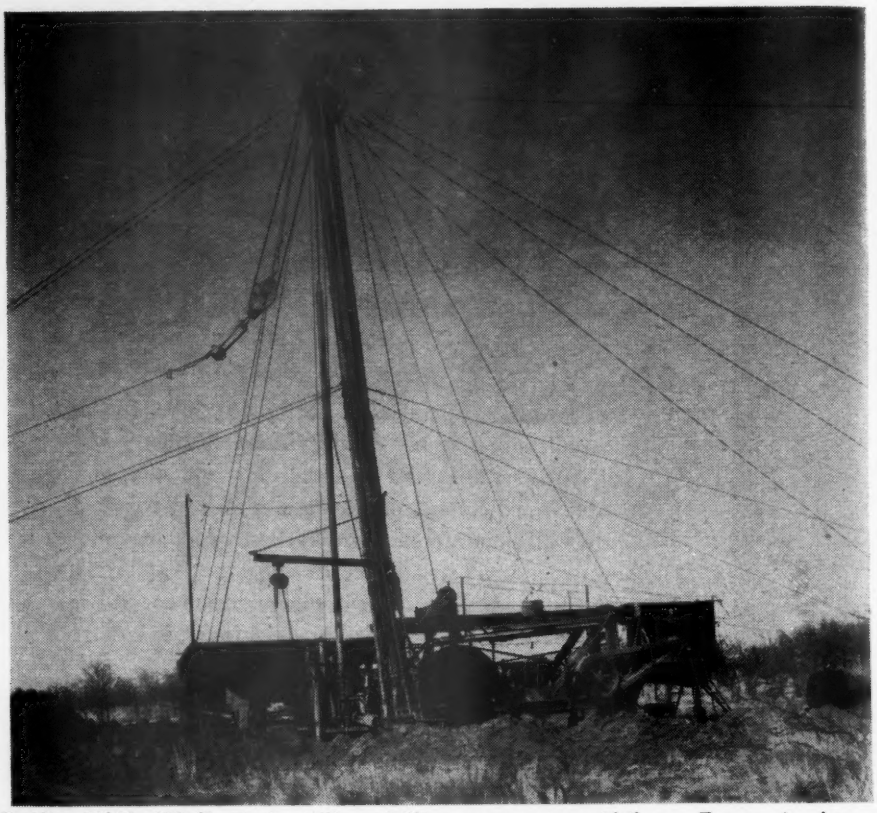
Open Peru Sand

A new Peru sand pool has been opened in the southwest corner of Labette County, Kansas by The Razorback Oil Company of Coffeyville.

The new well, which is on the Roy H. Benning farm, is the fourth well in the area. It has been completed for an initial of 12 bbl of 28.4 gravity oil. The sand was topped at 182 ft and bottomed at 207 ft.

Shaw Visits Calgary

S. Fred Shaw, consulting engineer, San Antonio, Texas is spending the next two months in Calgary, Canada on work in the Turner Valley field. Most of the work will involve estimating future reserves. There is also a project being discussed to consider increasing gas-lift installations.



Drills Sixth Well. U. L. Miller, drilling contractor, Abilene, Texas, is shown drilling his sixth well. Operation of the spudder is continuous for each drilling job. Wells average 2500 ft in depth, and it takes about 25 full, 24-hr days to complete each job. Fuel consumption is 4 gal per hour.

Wilcox Brings In Producer

Wilcox Oil Company may have extended the Beckham County, Oklahoma, sector of the Elk City field six miles west of the fartherest west producer in the field at its No. 1 Dugger. Although officials feel reasonably sure production is from one of the same zones that is producing in the main part of the Elk City field, it may prove to be a new pool.

Drilled to a total depth of 11,057 ft, the well had a showing of oil and gas on a drillstem test between 10,950-11,050 ft and then made 2,000,000 cu ft of gas, through about 11,000 ft of mud, with a break beginning at 11,053 ft.

Salvage Dry Hole

A dry hole has been reclaimed in Limestone County, East Texas by Great Expectations Oil Corporation, to open a gas field. The No. 1 J. P. Key flowed at the rate of 15,000,000 ft of gas a day on open-blow test; through a 1/6-in. choke, it gauged 3,500,000 ft of gas a day.

Gets Lincoln County Well

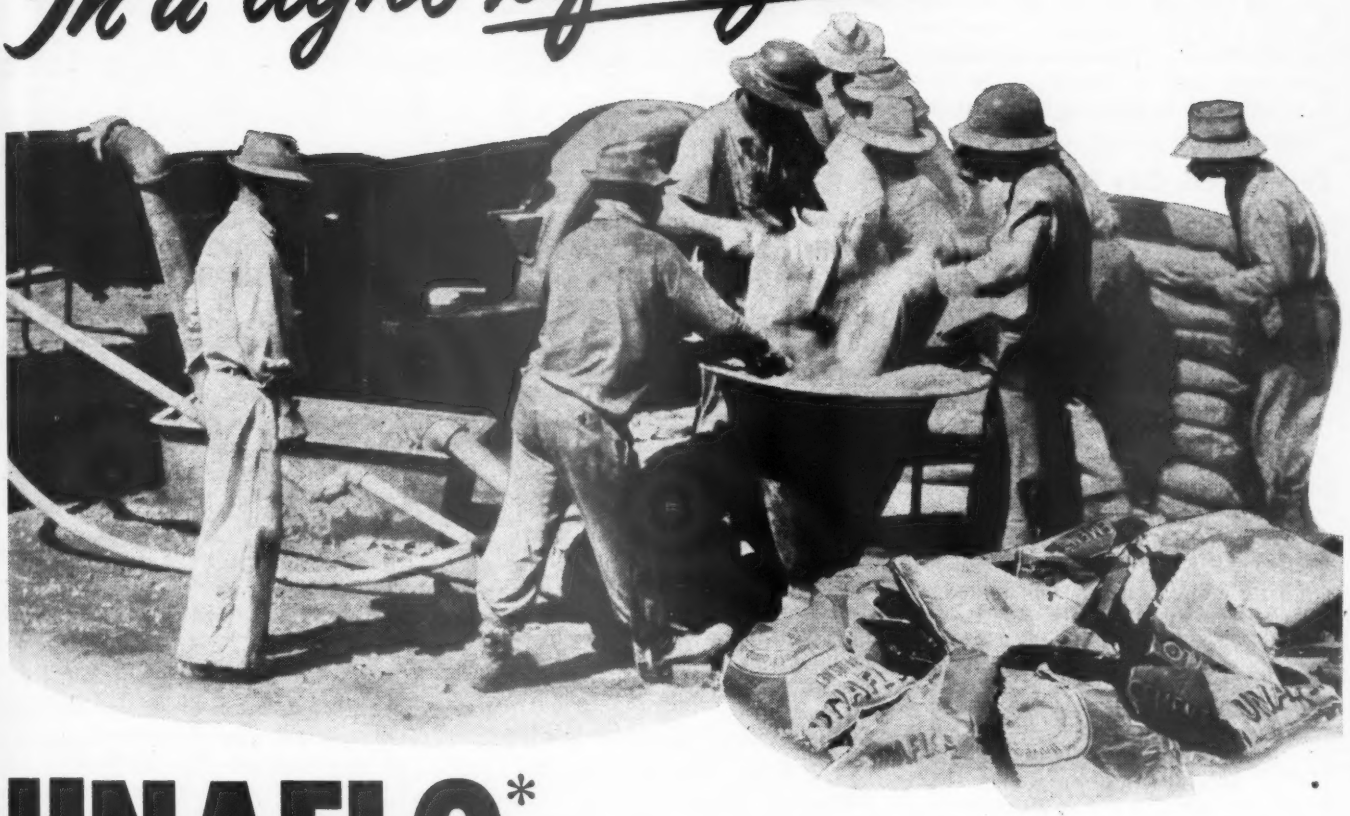
The Texas Company has completed its No. 2 Watson in Lincoln County, Oklahoma. The well, drilled to 4709 ft, flowed 212 bbl of oil in 9 hr through various sized chokes. Of the flow, 70 bbl was load oil used in hydrafrac treatment and 142 bbl was new oil. Gas flow was 440,000 cu ft for a gas-oil ratio of 780 to 1.

Continental Drills 2nd Meadow Creek Producer

Continental Oil Company has a second oil producer in its recently opened Meadow Creek field in Johnson County, Wyoming. This is Continental's third field in the general Sussex area of Wyoming.

The new well, the Meadow Creek Unit No. 2, was completed with a rated initial daily potential of 500 bbl, flowing through a 5/16-in. choke. The producer, situated 2000 ft northeast of the pool opener, Unit No. 1 well, is flowing 41.8 gravity oil through perforations from 7460-7482 ft in the Lakota sand. Total depth is 7528.

In a tight squeeze...



UNAFLO* protects your investment 3 ways

When you need extra time on a hot, deep squeeze—even when pressures rise above 5000 p. s. i. and temperatures hit over 200°F.—that's when you can rely on easy-pumping, hard-setting Unaflo Oil-Well Cement. It protects your investment in well, tools and equipment these three ways:

1. Unaflo stays fluid and pumpable under highest bottom-hole pressures and temperatures . . . high initial fluidity permits using heavy slurries.

2. Unaflo also has *sustained* fluidity because of its delayed, postponed, retarded set, which allows ample time, even during emergencies, to get cement in place.

3. After retardation, a heavy slurry of Unaflo hardens normally to form a dense, impermeable seal.

To be sure . . . always protect *your* investment with Unaflo.

• • •

Send for a helpful technical bulletin featuring oil-well applications of UNAFLO and easy-to-follow diagrams on various cementing operations. Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

**"UNAFLO" is the registered trade mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company*

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UNIVERSAL ATLAS CEMENT COMPANY

OIL-FIELD CEMENTS

Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters
Atlas Portland Cement—Type I
Atlas Portland Cement—Type II
Resistant to Sulfate Waters
Atlas High-Early Cement—Type III

NBC SUMMER SYMPHONY CONCERTS—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—June to September*

Sign Peruvian Contract

A contract has been signed by Dunlap and Graham of Long Beach, California, with the Peruvian government to drill 10 oil wells in the government petroleum zone of Zorritos. The section of land is situated in northern Peru.

Extends Elk City Field

Another well has been added to the Elk City pool of Beckham County, Oklahoma, with the completion of Shell Oil Company's No. 1 Kelly-B. This new producer adds first production for a new section, and extends the northwest side of the pool to the north. The well flowed 381 bbl of 58.7 gravity crude in 24 hr through 17/64-in. choke, with perforations at 9805-50 ft. Gas-oil ratio was 4660 to 1, with a gas volume of 1,776,000 cu ft.

Adds Well In Kansas Pool

Carter Oil Company has added a Viola lime producer to the Davis Ranch pool of Wabaunsee County, Kansas. Final pump test has been made at the company's No. 11-A Davis. Five and one-half casing was set on top of the producing area at 3160 ft. Total depth of the well is 3182 ft. It produced 469 bbl of 29.8 gravity oil, pumping for 24 hr.

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CHarter 5648

Rotary rigs operating in oil fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Oklahoma, Kansas	Arkansas, Lousiana, Texas	Illinois	Rocky Mountain, Canada	New Mexico, West Texas
1 st	2098	512	115	377	131	120	121	722
2 nd	2129	491	123	397	135	126	128	729
3 rd	2111	482	120	399	140	129	116	726
4 th	2164	498	121	411	131	135	144	724

*Figures released by American Association of Oilwell Drilling Contractors, as reported to them by Hughes Tool Company.

Drills Fourth Imperial Golden Spike Well

Imperial Oil has drilled its fourth successful well in the Golden Spike field in Canada. After penetrating the D3 section, Golden Spike No. 9 tested near the bottom of the 550-ft zone. The well gave gas at the rate of 400,000 cu ft a day and flowed oil to the surface in 22 min. Test interval was 5919 to 5970 ft.

The newest well is a mile north of the Golden Spike No. 1 (Shoepp No. 1) discovery well. The Canadian record-breaking well with production in D-2 as well as D-3 zone, is midway between the two.

Drills Garvin County Well

The Texas Company recently completed its No. 2 O. E. Neil in Garvin County, Oklahoma. The well flowed 56 gravity oil at a rate of 20 bbl an hour on a drillstem test between 7937-50 ft. With tool open 33 min, gas, estimated at 5,000,000 cu ft a day, showed in 2½ min and condensate in 22 min. Flow was through ⅝-in. bottom and ½-in. top chokes.

Wildcat Opens Strawn Pool

A newly completed wildcat in Jones County, Texas has opened a Strawn production field five miles east of Hamlin. Oxford Drilling's No. 1 J. L. Culbertson flowed 274 bbl of oil daily from pay topped at 5048 ft. Bottomed at 5062 ft, casing has been set at 5038 ft, before well was tested through a ¾-in. choke. Gas-oil ratio was 1228-to-1.

Complete Two Ohio Wells

Ashland Oil and Refining Company and George Covert and others have completed two good producers in the Lower Eastern field in southeastern Ohio.

In Licking County, Ashland and others completed the No. 3 William Bratton, in Hopewell township, for 85 bbl daily. The well also gaged 200,000 cu ft of natural gas. It logged Clinton sand at 2900 ft.

George Covert and others completed the No. 1 William H. Shaw in Monroe County, Green township. The well flowed 25 bbl daily from the Injun sand at a total depth of 1709 ft.

Scurry County, Texas Well Produces 138 Bbl an Hour

The No. 2 J. M. Reynolds in Scurry County, Texas has been completed by Warren Oil Corporation, subsidiary of Warren Petroleum Corporation, for a flow of 552 bbl of 48 gravity oil in 4 hr through a 1-in. choke. State potential is 3312 bbl a day. Production is from the Canyon reef, at a total depth of 6738 ft.

The No. 1 Reynolds was completed for a flow of 72 bbl of oil an hour. The new well is a west offset to the first producer.

Drills Record Number Wells

The completion of 58 successful oil wells in and around Calgary, Canada set a record for the month of April. Redwater field passed the older Leduc to register 406 producing wells as compared to 399 at Leduc.

Of the 58 new wells, Redwater accounted for 41, the Leduc-Woodbend area added 12, the Gilbert Lower Cretaceous field north of the Leduc Devonian field completed 1, 2 were completed at Excelsior, Stettler had 1, and Campbell brought in 1 Lower Cretaceous well.

Makes Argentina Find

A new oil zone has been discovered in the oil field of Punta Piedras, in the military zone of Comodoro Rivadavia in Argentina. Yacimientos Petroliferos Fiscales (Argentine State Oilfields) has made a new discovery at a depth of 7500 ft, the Minister of Industry and Commerce has announced. Production from the well is stated to be 150,000 litres per day.

Search for Oil in Italy

Western Geophysical Corporation of California has begun oil exploration in Modena, Italy, south of the Po River. Work is sponsored by the Italian State-controlled oil company, AGIP.

AAODC Moves Headquarters

Headquarters of the American Association of Oilwell Drilling Contractors and "The Drilling Contractor" have been moved to 321 Reserve Loan Life Building, 505 North Ervay Street, Dallas, Texas. Offices were formerly at 1412 Gulf States Building.

EXPLORATION ACTIVITIES

New Production Found In Louisiana Parish

New production has been opened in Louisiana, 2½ miles southwest of the Lottie field, Pointe Coupee Parish. The Texas Company has completed a large gas and condensate producer, the No. 1 V. J. Kurzweg et al, which flowed 9,424,000 cu ft of gas daily through a ¼-in. choke. Also the new well flowed 336 bbl of condensate from 10,324 to 10,330 ft. Tubing pressure was 5350 lb.

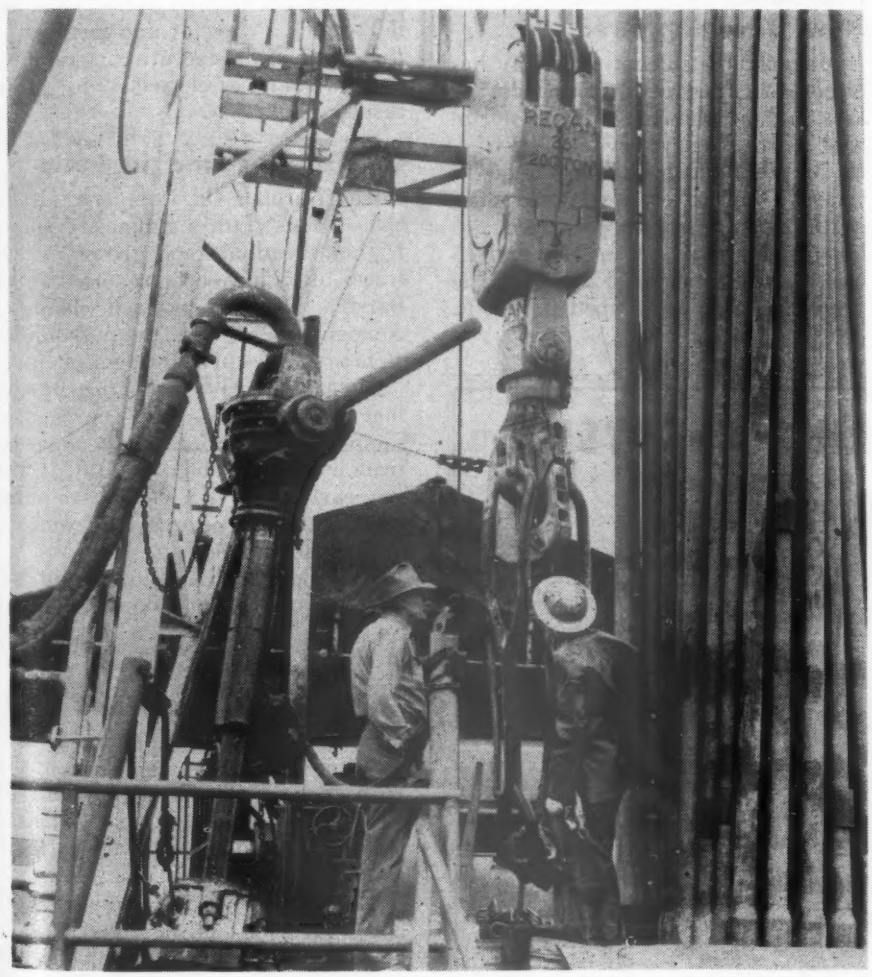
Open Adams County Field

A new field has been opened in Adams County, Mississippi with the completion of Humble Oil and Refining Company's No. 1 James Giles, about two miles north of the city limits of Natchez. The well is flowing from perforations at 10,154-60 ft at the rate of 115.2 bbl of oil per day through ⅛-in. choke. It had a gas-oil ratio of 3730 to 1, and gravity is 54.4 deg.

Hole is bottomed at 10,167 ft with 7-in. production casing cemented to this depth.

Reef Strike Made In Lynn County

The Canyon reef province has been extended into southeastern Lynn County in West Texas. Magnolia Petroleum Company is extending the reef at its No. 1 Garza Land and Cattle Company. Reef was topped at 8615 ft. On drillstem test at 8585 to 8630 ft, the well showed gas in 8 min and flowed 14.25 bbl of 41 gravity to tanks in one hour. The well gave the county its first oil field, and established lime-reef pay the fartherest west yet on the eastern platform of the Permian Basin.



Survey Drilling. J. H. (Jimmie) Lowe, tool pusher, and W. W. Parmley, driller for W. H. Black Drilling Company, Inc., of Midland, Texas, look over the Regan 36-200 traveling block and combination hook on portable Rig No. 1 currently drilling near Snyder, Texas.

Two Indiana Discoveries Open New Producing Areas

Two new discoveries have been completed recently in Posey County, Indiana. The C. E. Skiles' No. 1 William Aldridge is testing the Cypress sand at 2483 to 2505 ft. Total depth is 2505 ft. On a one-hour drillstem test from 2493 to 2505 ft, the well produced 540 ft of gas, 205 ft of clean oil, 60 ft of oil cut mud, and no water. This well is one and one-half miles from other oil wells and opens a new area.

The No. 1 Ben Rietman, drilled by W. C. McBride, Inc., opened another new producing area in Indiana. Total depth of the well is 2325. On a one-hour drillstem test from 1123 to 1205 ft on the Mansfield sand, the well recovered 405 ft of clean oil and 160 ft of oil cut mud.

Opens Oklahoma Pool

A new pool opener is being tested in Lincoln County, Oklahoma by Creekmore-Rooney and others at their No. 1 Elmer James. The well topped the Prue at 3061 ft, and at a total depth of 3113 ft. A shot was placed in the Prue section and the well flowed 57 bbl of oil and 7,000,000 cu ft of gas in 19 hr.

Warren Opens New Area

Another producing area has been opened in prolific Scurry County, Texas. Warren Oil Company, subsidiary of Warren Petroleum Corporation, opened the new area with the completion of its No. 1 Cunningham, a test 15 miles north of Snyder.

The well flowed 51 bbl of oil an hour through 1-in. choke on 8-hr test, or an indicated production of 1200 bbl daily on restricted flow. This was done, despite the fact that the well was being produced from only a small section of the available producing zone. Flow is from the Canyon reef topped at 6830 ft; total depth 6900 ft. Nearest production is 1½ miles to the northeast and 2¼ miles to the south.

Open New Illinois Oil Area

Sam Dedman-Hernon Drilling Company and LaGrange Petroleum Company have discovered a new oil area in White County, Illinois 2½ miles from Lynnfield. Discovery well is the No. 1 Isadore Dunn. The Aux Vases sand swabbed 130 bbl of oil in 8 hours at 3280 to 3288 ft, total depth. The well was stopped in saturated sand.

Sinclair Completes 2 Louisiana Wildcats

Sinclair Oil and Gas Company reports the completion of two new wells in Point Coupee Parish, Lousiana. Wildcat No. 1 Kimball, located in the southeastern part of the parish, flowed on preliminary tests at the rate of 237 bbl daily of 41 deg gravity oil through 10/64-in. choke, with a gas-oil ratio of 1320 to 1. Casing was set at 9281 ft and perforations made from 9205 to 9210 ft.

On the east side of this same block, the No. 1 Green has been drilled to a total depth of 10,300 ft and casing is now being run. In drilling this well, several sands showing both oil and gas were encountered, all of which are expected to be productive. It is anticipated that this well will extend the Fordoche field into this jointly held block.

Greenbrier Opens Oil Pool

Promise has been shown of a new oil pool at the Greenbrier Oil Company's No. 1 Wentzell in McClain County, Oklahoma. On a drillstem test of the Bromide sand between 10,668-93 ft, with tool open one hour, the well flowed 39.6 gravity oil at a rate of between 40 and 50 bbl an hour.

Production was through one-half inch top and bottom chokes with 2000-ft water cushion. Gas showed in 25 min, the water cushion in 26 min, and it began flowing oil in 42 min. Surface flow pressure was 3350 lb, and shut-in pressure, 4600 lb in 15 min.

Major Discovery Made In Hockley County

A new well in the Canyon Reef producing formation has been brought in in Hockley County, West Texas by Honolulu Oil Corporation and Signal Oil and Gas Company. At their No. 1 Underwood four miles south of Smyer, oil flowed at a rate estimated at 75 to 150 bbl of 41 gravity oil hourly, the last nine minutes of the test. The top of the Canyon Reef formation was said to be 9285 ft. Operators reported "there was a heavy blow of air as the test began" and the oil flowed within 18 to 21 min.

Makes Clay County Strike

With the completion of the L. T. Burns No. 1 Tate, a new strawn sand oil pool has been opened in Clay County, Texas. The new well flowed 300.96 bbl of 43 gravity oil in six hours, through ¾-in. tubing choke, for a calculated daily potential of 1203.84 bbl. It is three miles northeast of the Chapman Strawn sand pool, the closest Strawn production.

Magnolia Well Finds New Devonian Area

Magnolia Petroleum Company has discovered a new Devonian producing area in New Mexico, 30 miles northwest of the Bagley Devonian district. Its No. 1 Lightcap Land Company in Chaves County, New Mexico, 35 miles northwest of Roswell, produced 146 bbl of 52 gravity oil in 2 hr and 15 min. Gas-oil ratio was 1527 to 1. The producing zone was topped at 7970 ft.

Pratt Awarded Kemp Medal for Geology

Wallace E. Pratt, one of the leading petroleum geologists of the present generation, was honored recently by Columbia University, when he received the Kemp Medal at a dinner program in the Men's Faculty Club. The award, given for "distinguished service in geology," was presented by Dwight D. Eisenhower, president. The presentation was followed by an address by Donald H. McLaughlin, president of the Homestake Mining Company and president this year of the American Institute of Mining and Metallurgical Engineers.

Pratt received his scientific training at the University of Kansas, from which he was graduated in 1907. In 1909 he went to the Far East as geologist for the Division of Mines, Government of the Philippine Islands, and three years later was made chief of the division. Returning to this country in 1916, he was associated first with The Texas Company and later, for many years, with the Humble Oil and Refining Company. Joining Standard Oil of New Jersey in 1937, he became a director and member of that company's executive committee, and in 1942 was elected a vice president.

Oil Traces Found In India

The Burmah Oil Company (India Concessions) Ltd., announced from its Digboi headquarters recently that traces of oil have been reported at the Barsilla, (Assam) test-well where the company is exploring the possibilities of new sources of petroleum in India.

Messages received from the site said that slight signs were occurring in samples of sandstone rock brought up from a depth of about 4000 ft. It was too early, the BOC said, to judge whether the oil occurred in commercial accumulations.

Barsilla, which is situated in the Assam jungle about 14 miles south of Sibsagar, has hitherto yielded no sign of being oil-bearing.

Kansas Gets New Field

A new pool has been added to Graham County, Kansas, southwest of the West Morel field. Peel-Hardman Oil Producers are finding Lansing-Kansas City lime production at their No. 1 De Sair in Graham.

The Lansing was topped at 3596 ft and went to a total depth of 3977 ft before plugging back to 3800 ft after casing was run to 3830 ft. The well was perforated at 3622-29 ft, and the zone was treated with 1000 gal of acid. On initial swab test showed 32 bbl of oil per hour for three hours.

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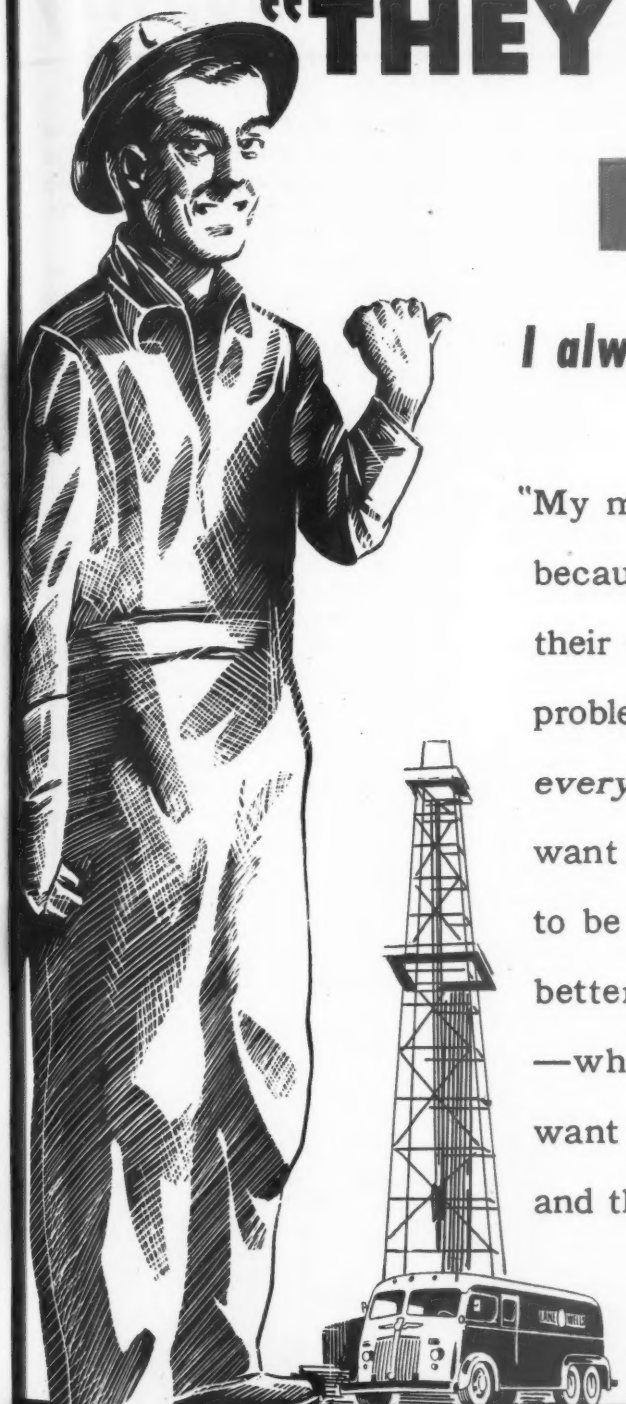

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running tour with men in the industry

Kenneth L. Smith has taken over duties with Champlin Refining Company as chief production engineer. He will be stationed at Champlin's general offices in Enid, Oklahoma. During the past eight years, Smith has been associated with Stanolind Oil and Gas Company in various engineering capacities.

Smith was a geology major at the College of Wooster, Wooster, Ohio, and also a graduate of the University of Pittsburgh, Pittsburgh, Pennsylvania, receiving a BS degree in petroleum engineering at the latter school. Immediately upon graduation, Smith joined Stanolind Oil and Gas Company as a trainee engineer in 1942, in which capacity he served for one year prior to his entering the U. S. Army Air Force. At the time of Smith's resignation with Stanolind, he was serving as a petroleum engineer for West Texas operations at Levelland, Texas.

Heber Beardmore, Jr., Beardmore Drilling Company, Wichita, Kansas, has been made chairman of the program committee, of the Kansas Chapter of American Association of Oilwell Drilling Contractors. Other members of this committee include: **F. M. Stevenson,** Signal Oilfield Service, Great Bend, and **Chester Williams,** Flournoy and Williams, Wichita.

Publicity for the chapter will be handled by a committee made up of **W. J. Coppinger,** Coppinger and Southern, Wichita, chairman; **Fred Stickle,** Stickle Drilling Company, Great Bend; and **Thomas M. McCall,** Quaker Drilling Company, Wichita.

J. D. Adkins, Adkins Drilling Company, Great Bend, vice chairman of the Kansas chapter, has been appointed chairman of the membership committee, which includes: **W. S. Brunson,** Brunson Drilling, Wichita, and **John M. Little,** Jayhawk Drilling, Wichita.

A committee to study transportation problems of the drilling industry in Kansas includes: **C. L. Roberts,** B. & R. Drilling Company, Russell, chairman; **A. R. Peters,** Powell and Peters Drilling Company, Great Bend; and **E. R. Sloyer,** R. W. Rine Drilling.

Other chapter officers include **E. L. McCartney,** B. & R. Drilling Company, Wichita, vice-chairman, and **B. W. Burks,** Derby Drilling, Wichita, secretary.

Walter Shute was recently appointed manager of the Mexico City office of Kerr-McGee Oil Industries, Inc. Kerr-McGee is in charge of drilling for Mexican American Independent Oil Company's program in Mexico.

George H. Fentress recently resigned from Phillips Petroleum Company, and has accepted a position as geologist with Lion Oil Company. Headquarters will be at Jackson, Mississippi.

T. E. Swenson, manager of the land department, Deep Rock Oil Corporation, Tulsa, Oklahoma has been elected president of the Tulsa Landman's Association.

Other officers elected are: **I. W. Pilkington,** Barnsdall Oil Company, vice president; **Roy Dunlop,** Sun Oil Company, secretary, and **H. T. Carpenter,** The Ohio Oil Company, treasurer.

Members of the executive committee are: **A. L. Chapman,** Wilcox Oil Company; **Tarz Marsh,** The Carter Oil Company; **George A. Schwab,** Barnsdall Oil Company; **C. E. Barnes,** Pure Oil Company, and **G. W. Lackey,** Stanolind Oil and Gas.

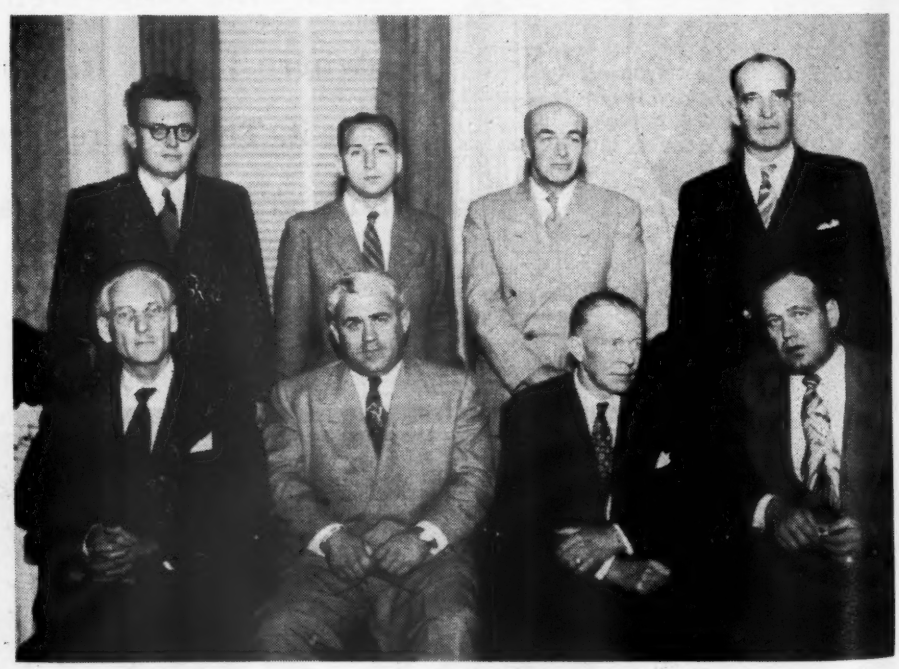
Wesley G. Gish, vice president of the land and exploration division of Deep Rock Oil Corporation, is leaving the company to enter the private practice of petroleum geology.

A graduate of the University of Nebraska, Gish has been active in oil exploration in the Mid-Continent and Gulf Coast states since 1921. He will continue to reside in Tulsa, Oklahoma.

R. L. Fillner, former Grand Rapids, district production manager of The Ohio Oil Company, has been appointed division landman of the Casper, Wyoming, division, W. B. Emery, manager of production, has announced. He succeeds **D. W. Sellery,** recently deceased.

Fillner joined the Billings Gas Company, a subsidiary of The Ohio Oil Company, in 1922, and was placed on the scouting and leasing staff of The Ohio's Wyoming division in 1928. Transferred as a landman to the Findlay, Ohio, division in 1940, he was appointed acting division superintendent in 1945.

With the consolidation of the company's eastern producing divisions in 1948, Fillner was transferred to Grand Rapids, Michigan, as district manager.



L. A. Nomad Guests. Foreign visitors at the Los Angeles Nomads April Meeting are: Front row, E. N. "Whitey" Mitchell, Phillipine Oil Development; E. W. Hannay, Arabian American Oil Company; R. H. Deem, Shell of Colombia; V. E. Freel, Drilling and Exploration, Brazil. Back row: F. Vermersch, S.C.P., French Morocco; Gerard Landroit, S.N. Repal, Algeria; H. G. Karnes, Iraq Petroleum; B. L. Coker, I.P.C. Syria. Highlight of the evening was the showing of the San Francisco fair by Roy L. Driscoll.

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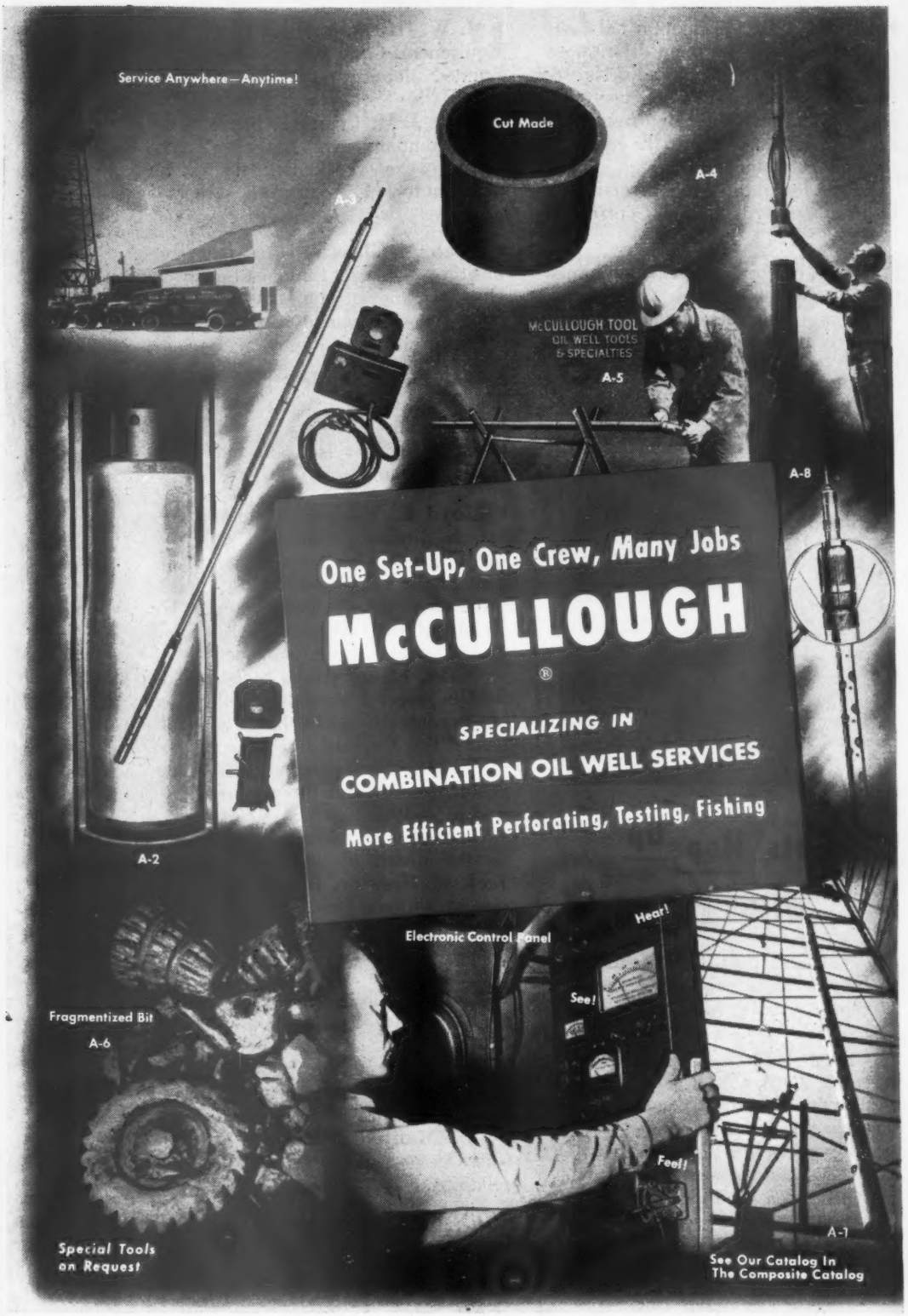

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▸ **J. S. Royds,** Continental Oil Company, has been appointed division geologist, at Denver, Colorado. He was formerly assistant division geologist. Royds succeeds **A. E. Brainerd** who retired after serving with the company continuously since 1924.

A graduate of the University of Colorado, Royds joined Continental in 1939.

▸ **Pete Cawthon** has recently joined the City National Bank of Houston, Texas as a reservoir engineer. He was formerly reservoir engineer with Phillips Petroleum Company in its Midland, Texas, division office.

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▸ **M. W. Hiltpold,** Buda Engine and Equipment Company, has been appointed deputy sergeant-at-arms of the Dallas-Fort Worth Nomads. He replaces **J. M. (Jim) Bridges** of the same company, who has been transferred to New York. Hiltpold will be assistant to **J. E. Everroad,** sergeant-at-arms.

▸ **Theo A. Glass** resigned from his position as district geologist for Eason Oil Company at Mount Vernon, Illinois. He will become an independent operator and consultant.

▸ **Warren J. Souder,** geologist for The Texas Company, has been transferred from Casper, Wyoming, to Craig, Colorado. He will retain his same position.

▸ **Lloyd E. Elkins,** production research director, Stanolind Oil and Gas Company, has been elected president of the Engineers Club of Tulsa, Oklahoma. He succeeds **Ernest M. Newland** who retired from office June 1. A graduate of the Colorado School of Mines, Elkins joined Stanolind as field engineer immediately following his graduation in 1934. He also attended the Harvard Graduate School of Business Administration, becoming production research director of Stanolind in 1949.

Other elected officers who will make up the board of management are: **Jack H. Beesley,** Baroid sales division of National Lead Company, executive vice president; **Dale G. Savage,** Service Pipe Line Company, treasurer; **William R. Clark,** Jones and Laughlin Supply Company, vice president in charge of programs; **J. E. Byers,** Black Sivalls and Bryson, vice president, membership; **Walter S. Smith,** Process Equipment Company, vice president, entertainment, and **P. P. Manion,** Stanolind Oil and Gas, vice president in charge of public relations.

Newland, past president, automatically becomes a director to serve with two electees, **W. L. Horner,** Barnsdall Oil Company, and **L. A. Ogden,** Pure Oil Company. **H. T. (Jack) Frost** continues as executive secretary.

▸ **J. R. Huffmyer,** district geologist, American Republics Corporation at Artesia, New Mexico, has resigned his position with the company. In the future he will be associated with Kewanee Oil Company, Tulsa, Oklahoma.

▸ **Frank Whitson,** Phillips Petroleum Company, producing foreman at Beaumont, Texas, has been transferred to Burmas, Louisiana. There he will be foreman in the Baston Bay area.

Roger L. Messman

▸ **Roger L. Messman,** assistant division geologist for Continental Oil Company, Ponca City, Oklahoma, has announced his resignation effective May 1, and his association with **William Graham,** Wichita independent oil operator. Together, Graham and Messman plan extensive exploratory and development work, initially in Kansas and Oklahoma.

Messman has spent eight years in geological work in Oklahoma and Kansas for Continental, joining Conoco in 1936 at Ponca City after completing his geological studies at the University of Oklahoma. His tour with Continental included experience in West Texas and Wyoming. He was appointed assistant division geologist in 1949.

▸ **Norval W. Nichols,** vice president of exploration for Rio Bravo Oil Company, was recently elected a director and made vice president of Great Plains Development of Canada, Ltd. The field-operations staff will be established under his supervision at the Calgary, Alta., office.

Nichols served with Superior Oil Company of California during the past 12 years in Texas, Canada, New Zealand, including 7 years with Rio Bravo, the Canadian operating subsidiary.

▸ **Hugh M. Thralls,** Seismograph Service Corporation, has been elected president of the Geophysical Society of Tulsa, Oklahoma. **Paul L. Lyons,** Carter Oil Company, and **Neal Clayton,** Republic Exploration Company, have been elected vice presidents; **Robert C. Kendall,** Shell Oil Company, has been elected secretary, and **William M. Erdahl,** Skelly Oil Company, treasurer.

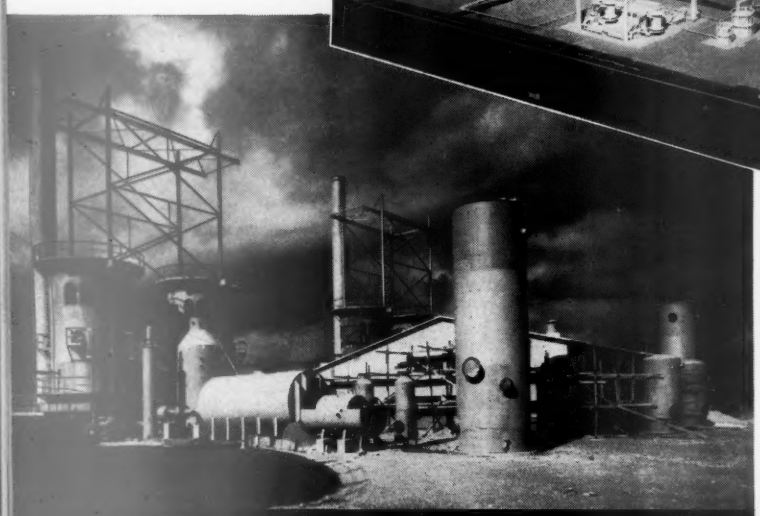
REFINING AND GAS PROCESSING SECTION

Quart canning machine in Phillips Oil Company's new compounding plant, Kansas City, Missouri.

Progress Report by Chemico

LARGE FERTILIZER PROJECT FOR EGYPT

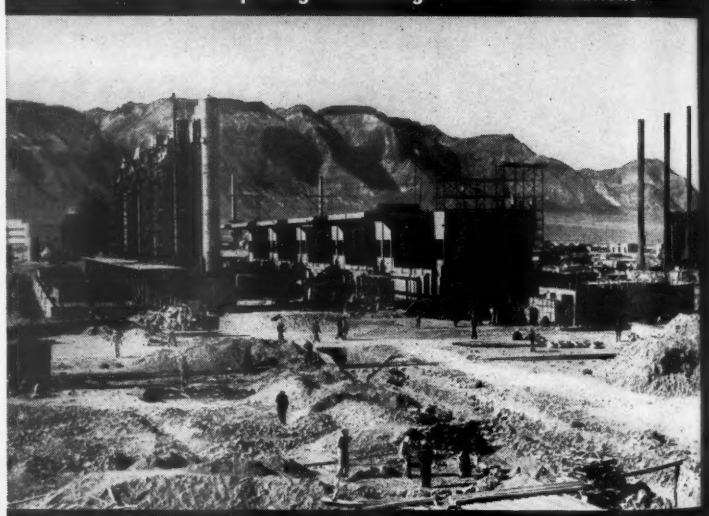
Model of fertilizer works built before project was initiated



Gas reformers to convert refinery gas to hydrogen and nitrogen

Local craftsmen placing reinforcing steel for foundations

Nitric acid absorption towers and ammonia storage tanks



General view of the project which covers an area of 1350 acres

These photographs show work in progress on the 550-ton per day fertilizer plant being built at Suez, Egypt. This important Chemico project includes plants for the production of synthetic ammonia, nitric acid and calcium nitrate together with complete facilities for supplying utilities such as power and water to the various units. This is one of a number of world-wide Chemico activities which include projects in Formosa, India, Mexico, South Africa and Brazil. Whatever your problem may be in the production of heavy chemicals ... wherever it may be ... you can be sure that Chemico will deliver a highly efficient plant on a guaranteed-performance basis.

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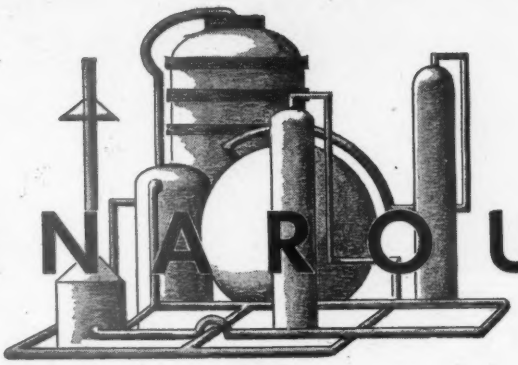


THE TURNAROUND

Refiners Must Be "Soothsayers"

PROGNOSTICATION of coming events is no less important to the modern refiner than were the predictions of the soothsayers to the ancients, according to some of our most outstanding refining leaders. The challenges made to refiners include those of an emergency nature and those that are long range in character. Differing in time factor, these problems are essentially of the same composition, says Chester F. Smith, refining vice president of New Jersey Standard, and current head of the API Refining Division activities.

Our abilities in forecasting the nature and duration of our long range requirements have determined in great measure our success in handling emergency problems. It is increasingly necessary that the refining industry be able to foretell with good accuracy the future demands in quantity and quality of products, to decide the time factor involved in these matters.

Outstanding in our recent history is the completion of the transition period from a shortage of products to an overproduction and a curtailment of refinery outputs, Smith states. Without ability and facilities for forecasting future demands the industry will be victim of alternating periods of shortage and of excess capacity.

From using more than 90 per cent of our total refining capacity in 1946-48, we have reached the point of operating only 80 per cent of capacity, late in 1949, with every prospect of continuing this rate in 1950. Much of the refiner's problem is that of logistics—having the required amounts of the needed products at the indicated locations at the proper times; a "war need" if you please.

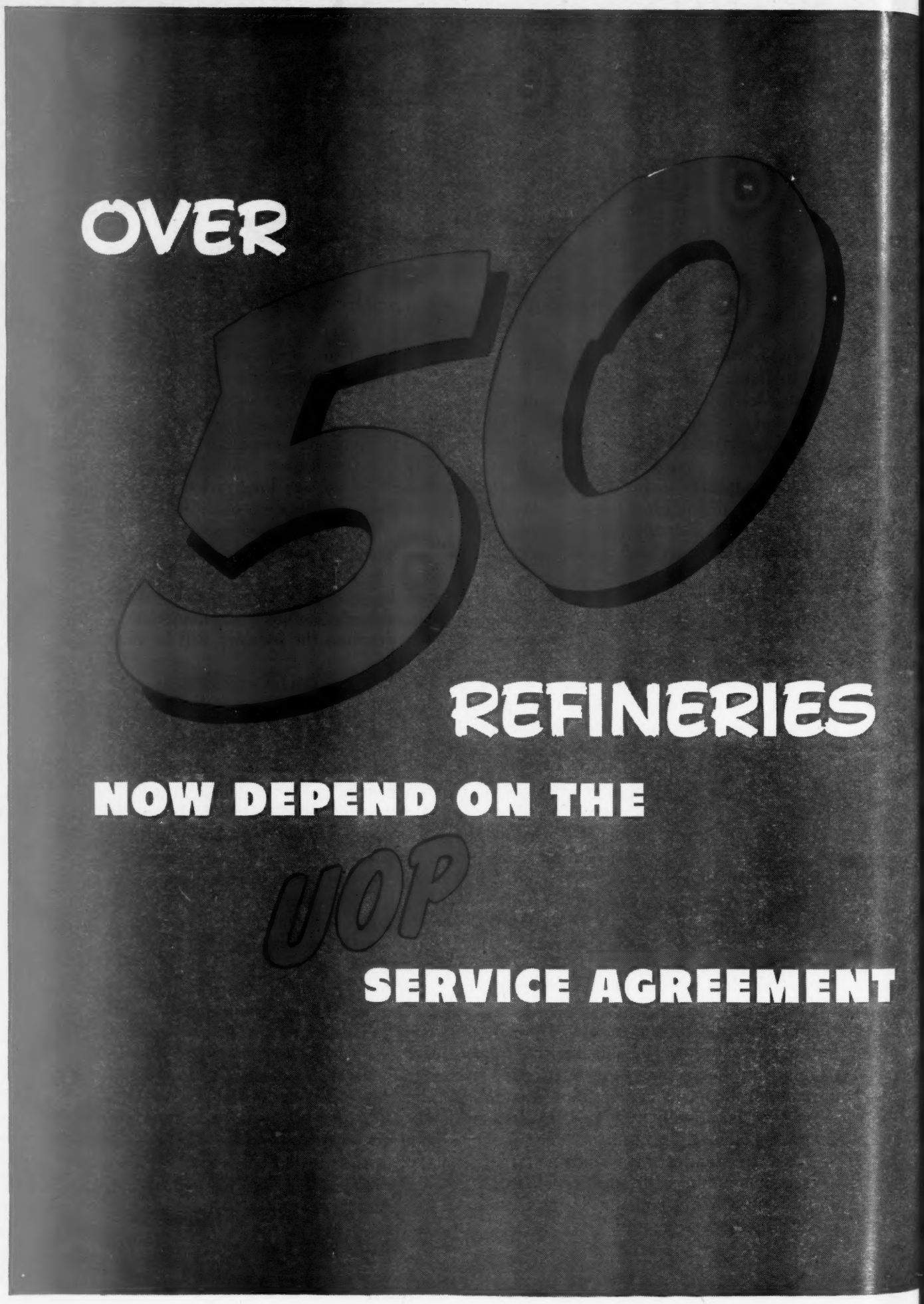
One of these important activities occupying the refiner's efforts has been that of reduction of residual fuel oil production. Here catalytic cracking has come into its own, due to ability to make distillate instead of residual fuels, along with catalytic reforming.

Motor gasoline quality, the "octane race," is tied in complicatedly with refining economics and competition; 1949 showed that octane averages were upped strongly, following a curve set prewar. This whole picture is a long-time trend, must be gauged accurately by refiners if they are to give the customer the most in required quality for his money, at the same time utilizing most efficiently our natural resources. Octane rating rise in future, in the face of increased refining costs is a trend on which we can only speculate.

Natural gas will be an active competitor against distillate and residual fuels in future, but need not cause "a severe dislocation in present refinery plans," Smith believes. The jet fuel demand bids fair to become a factor, what with Canadian and British airplane makers building jet-powered airliners, and the probability that American designers will follow suit. A relatively long range project, it is indispensable that we include this as one of the important developments in our future refining planning. Petroleum-derived chemicals are here already in large volume, typical being a billion pounds of synthetic petroleum-originated detergents annually, with many others in huge quantities.

The freedom of this country is largely a matter of the health of its industry. We must expect some public criticism; provide means to clarify the public's thinking on matters such as the "need" for synthetic fuels; must have the refining flexibility to meet changes in product quality or quantity.

Arch L. Foster


OVER
50
REFINERIES
NOW DEPEND ON THE
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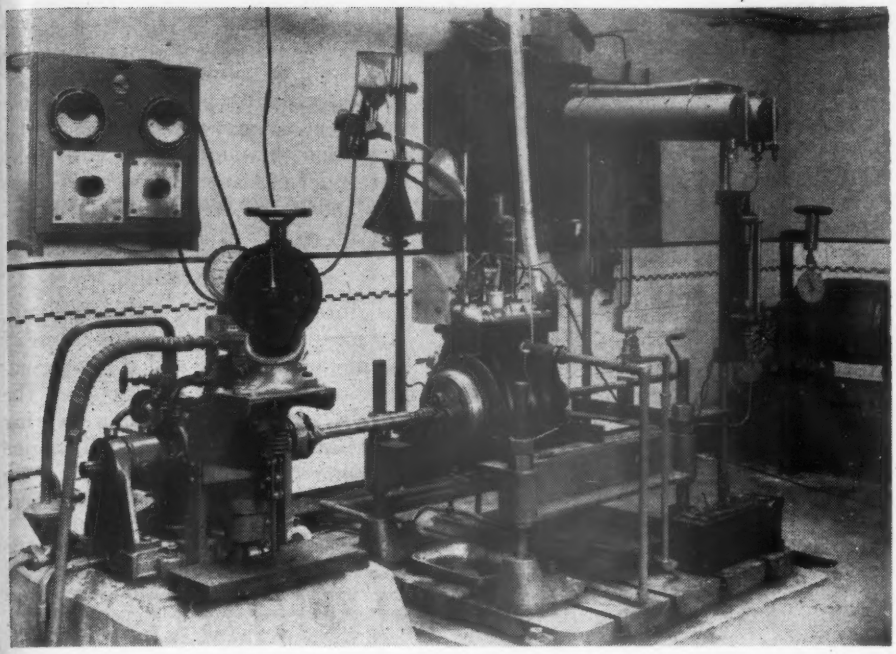


FIG. 1. Layout of test plant for filter experiments.

Maintenance of Internal Combustion Engines— Filtration of Air and Oil*

PHILIP H. MOORE**

This and following articles will show what happens to a conventional, four cylinder, gasoline engine after running for 57 hours in a dust atmosphere with no filters, with an air filter and with air and oil filters.

It is not difficult for engine operators to understand that a power plant should run better if steps are taken to see that the air and lubricating oil do not contain foreign matter. Filter manufacturers assure him that this is a fact, but if he were to ask "how much better" or "which components of the engine will be affected" then he may not be satisfied with the reply unless comparative test data are available.

These tests were planned to answer such queries and so three identical trials were run, each time starting with the same engine in the same condition. In all cases an identical type and quantity of dust was fed to the air intake. In the first trial no filters were used, in the second the air intake was fitted with an air filter and in the third trial the engine was equipped with both air and full flow oil filters.

Dust Atmosphere

The dust atmosphere was created by feeding an artificial dust into the air intake stream. The quantity, chemical composition and particle size distribution were decided from a study of published data on road dusts.[1]

The exact conditions chosen were as follows:

1. Continuous feed of dust at the rate of 0.236 gms./1000 cu ft of air.

2. Dust made from silica to the following size distribution:

90.4 per cent by wt.	53—20 microns.
5.1 per cent by wt.	20—10 microns.
2.0 per cent by wt.	10— 5 microns.
2.5 per cent by wt.	5— 0 microns.

Equipment

Fig. 1 shows the layout of the test plant. The power unit was a four-cylinder side valve, four-stroke gasoline engine. Its bore was 57 m/m (2¼-in.) and stroke 100 m/m (4-in.). The engine lubrication system consists of a 45 psig feed from a gear pump to the crankshaft bearings. The little end bearings and valve mechanism were lubricated by splash.

In Fig. 1 is also shown a conventional water brake for absorbing the engine power output as well as a device for supplying the dust. The dust feed apparatus allowed a continuous supply down to half a gram per hour by employing a hopper and electrically vibrated chute. The feed rate was controlled by adjusting the angle of the chute.

Diagram 1 shows the air filter that was used for the 2nd and 3rd trials and Diagram 2 illustrates the method by which the dust feed was directed to the intake of the air filter. Diagram 3 shows the full flow oil filter as used in the third test.

Standardization of Engine

For a true comparison all wearable parts of the engine must be uniform before each test. This was accomplished by obtaining standardized stocks of liners, piston assemblies, bearing shells, crankshafts, valves and valve guides, and inserting a new set of components before commencing each individual test. The liners were inserted into the block and then bored out to a diameter, which was the same for all experiments.

Prior to each test, engine variables such as ignition adjustments, valve and bearing clearances were made to conform to those figures recommended by the engine manufacturer.

Fuel and Lubricating Oil

A large quantity of fuel was obtained, which was sufficient for all the tests so as to avoid any changes in fuel quality influencing results. It had the following properties:

Specific Gravity @ 60 F
= 0.7508
API @ 60 F.
= 57.

*A research sponsored by the Vokes Filter Company, England.

**Engineering consultant.

1. Summers, S.A.E. Journal, February and June, 1925. Hoffman S.A.E. Journal, February and March, 1925.

EXCLUSIVE

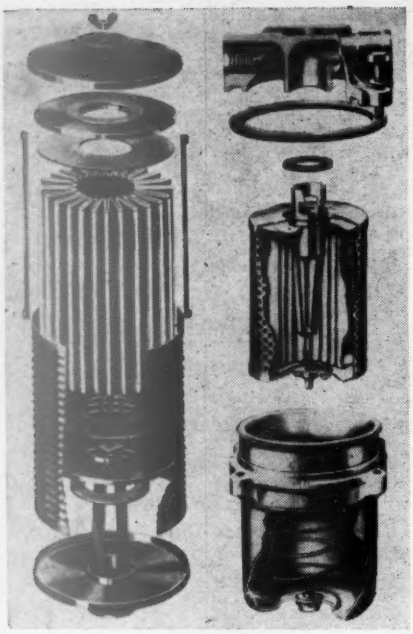


Diagram 1. Vokes air filter.

Diagram 3. Vokes full flow oil filter.

Initial Boiling Point
= 38°C (100.3 F)
Final Boiling Point
= 207°C (405 F)
Octane Number (Motor Method)
= 72
T.E.L./Imperial gal
= 0.4 c.c.
T.E.L./American gal
= 0.333 c.c.

The engine was lubricated with a non-additive oil and a standardized procedure adopted for measuring and topping up purposes.

The center main bearing shells and No. 4 piston assembly were chosen arbitrarily for comparison purposes, the others showed little variation.

Operating Conditions

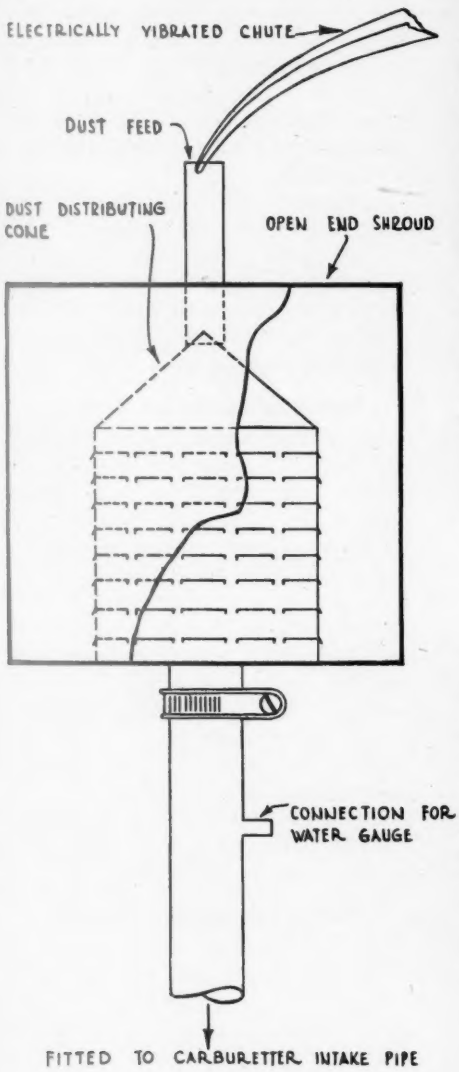
For each trial the running in period consisted of six hours at ¼ full load, 1750 rpm and six hours at ½ full load, 2000 rpm. The engine was then run for 45 hours at ¾ full load, 2500 rpm, to complete the test.[2]

Sump oil temperature was controlled at 69 ∓ 3 C (156.2 ± 5.4 F) by means of water cooled coil. Inlet and outlet coolant temperatures were regulated to 30-35 C (86-95 F) and 78-82 C (172.5-180 F), respectively.

Test Procedure

Before assembling the power unit, surface profile graphs were taken of the piston top land and the top compression ring from No. 4 piston. The surface of the center main bearing shell was also recorded. All engine components subject to wear were either measured for size or weighed.

2. Without filters the engine was not satisfactory for further use after this test duration owing to excessive wear. Therefore, this test time was standardized for all trials so that they would be comparative.



Sketch of assembly for feeding dust into air filter.

Diagram 2

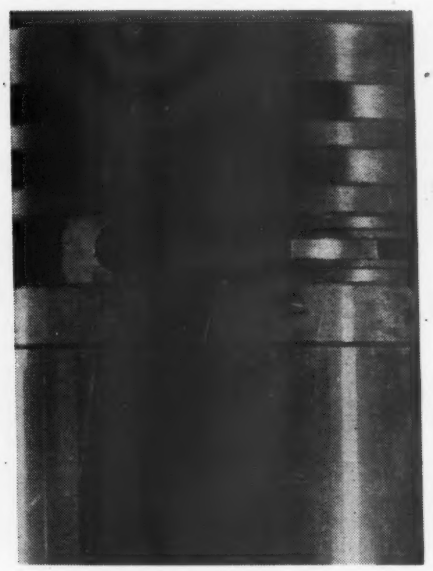


FIG. 2. Before test

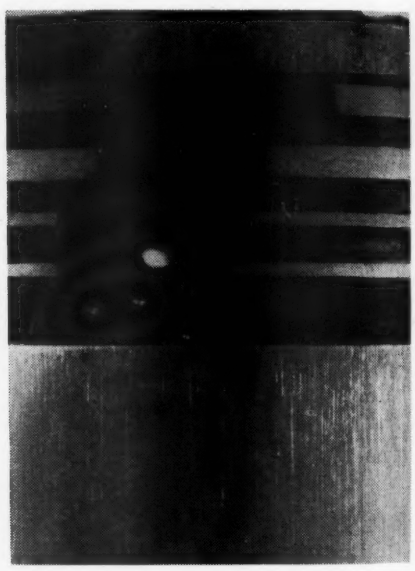


FIG. 3. After test with no filters.

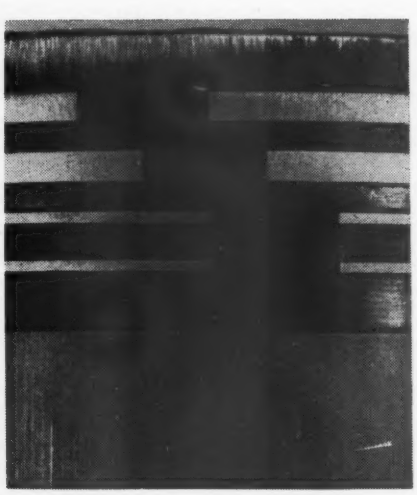


FIG. 4. After test with air filter.

FIG. 5. After test with air and full flow oil filter.

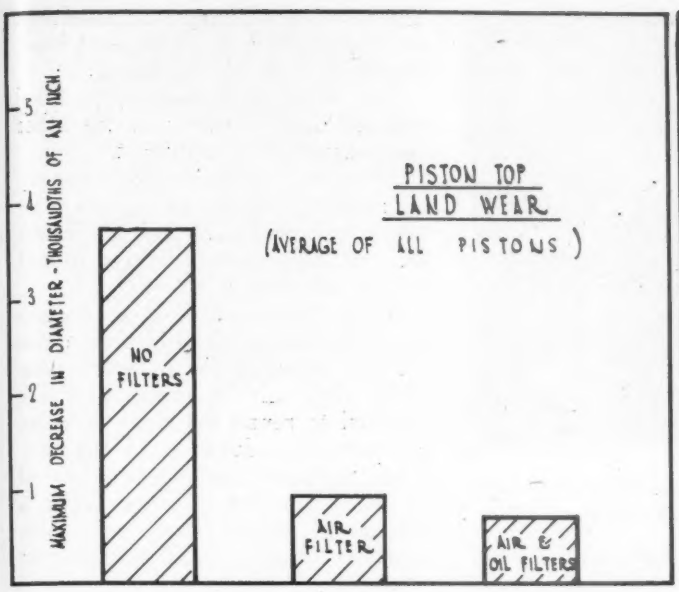


Diagram 4

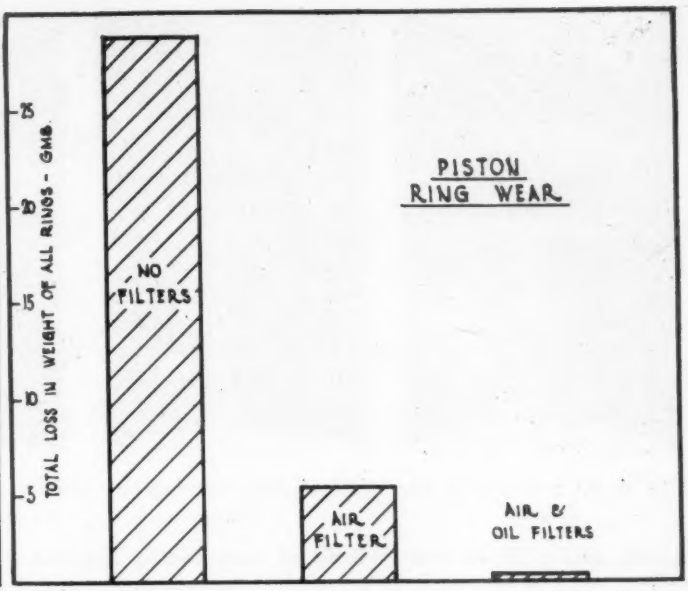


Diagram 5

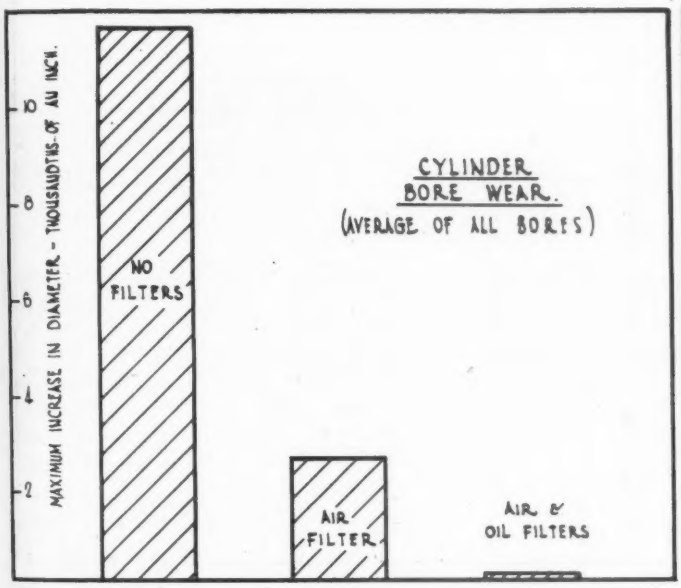


Diagram 6

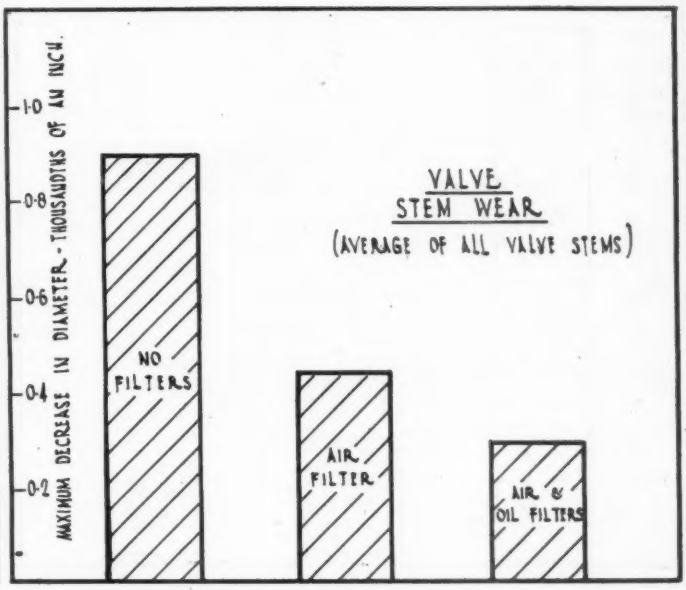


Diagram 7

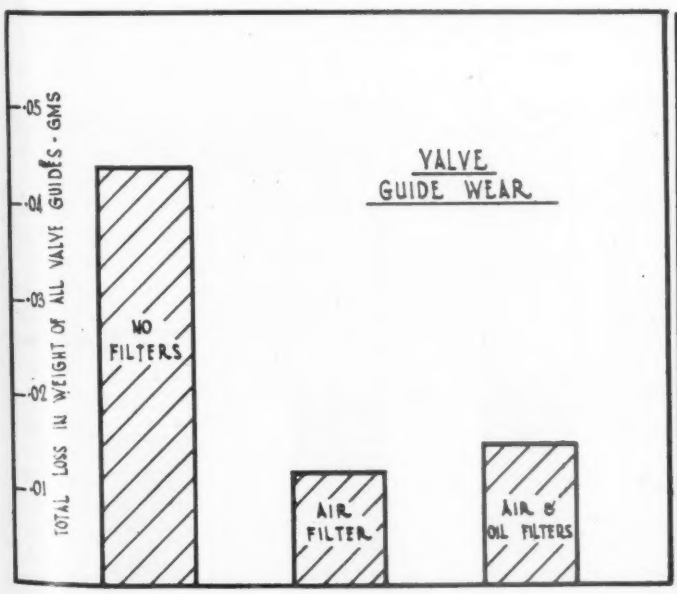


Diagram 8

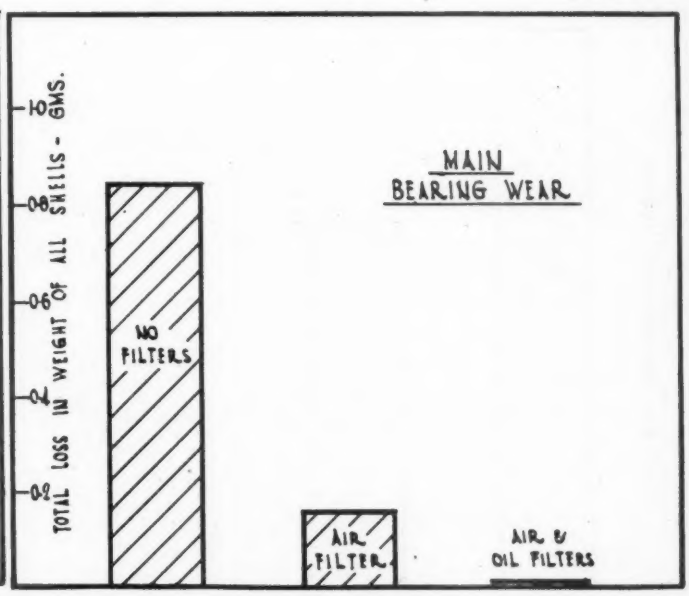


Diagram 9

FIG. 6. After test with no filters.

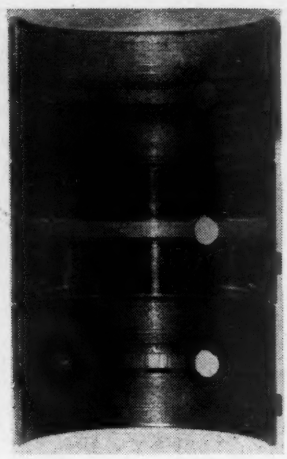


FIG. 7. After test with air filter.

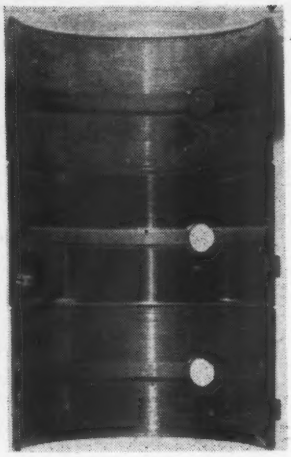


FIG. 8. After test with air and full flow oil filter.

A new shell is shown in the middle of each photograph, for comparison purposes.

The new No. 4 piston ring assembly, center main and No. 4 big end bearing shells were photographed.

The engine was assembled, filled with oil and connected to the other components of the test plant.

After the running-in period the engine's performance was checked by taking a power curve, if the results were satisfactory then the trial proper was commenced.

In the first trial, that is without filters, the engine developed excessive blow-by accompanied by spark plug oiling after only 28 hours. It became essential to renew the rings in order to extend the duration of the run. When the same phenomena occurred on the second set of rings (after a further 29 hours) there were also signs of bearing wear so this test

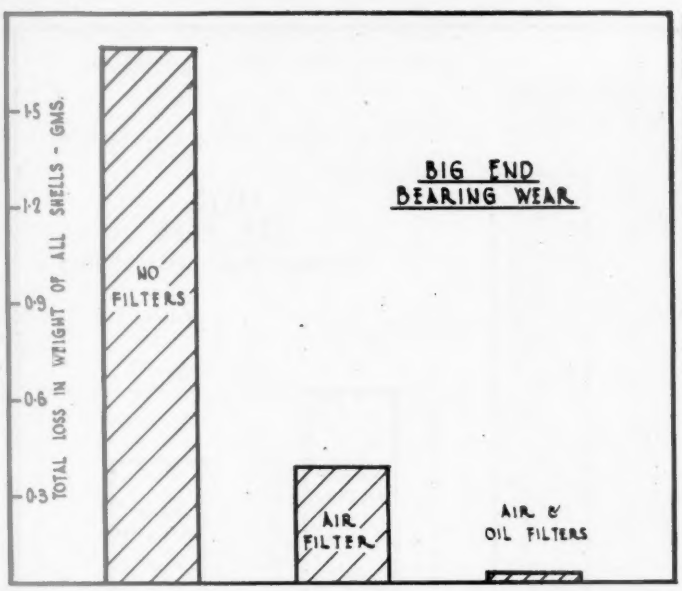


Diagram 10

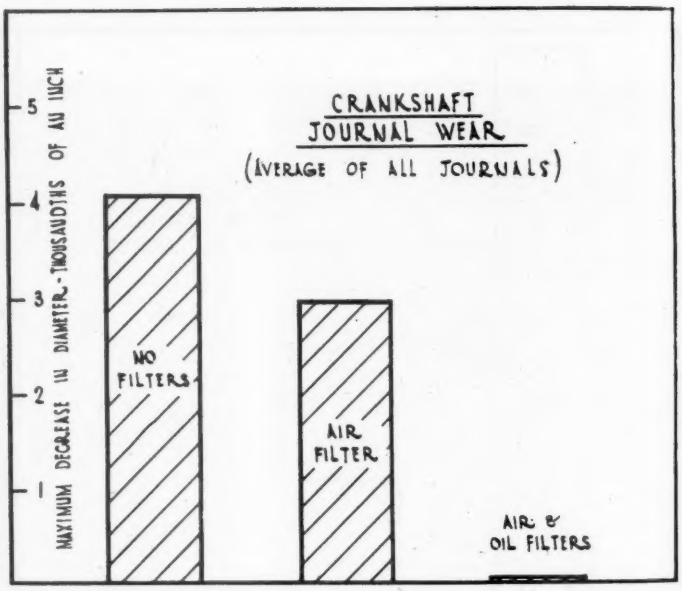


Diagram 11

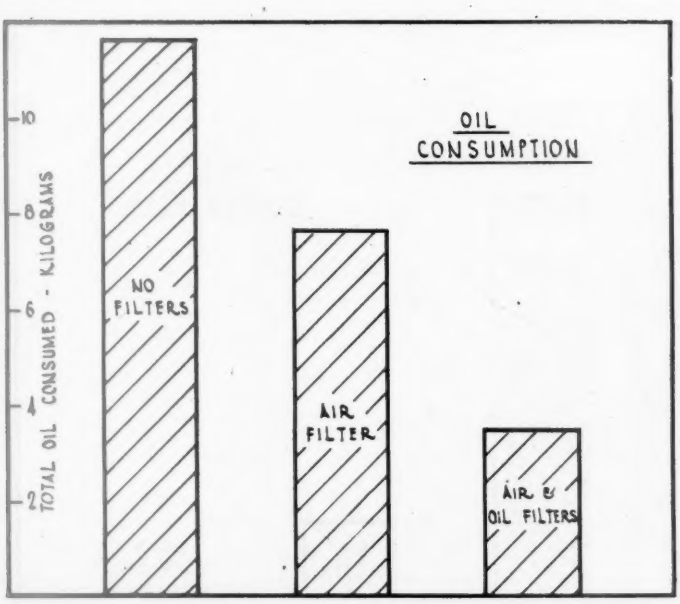


Diagram 12

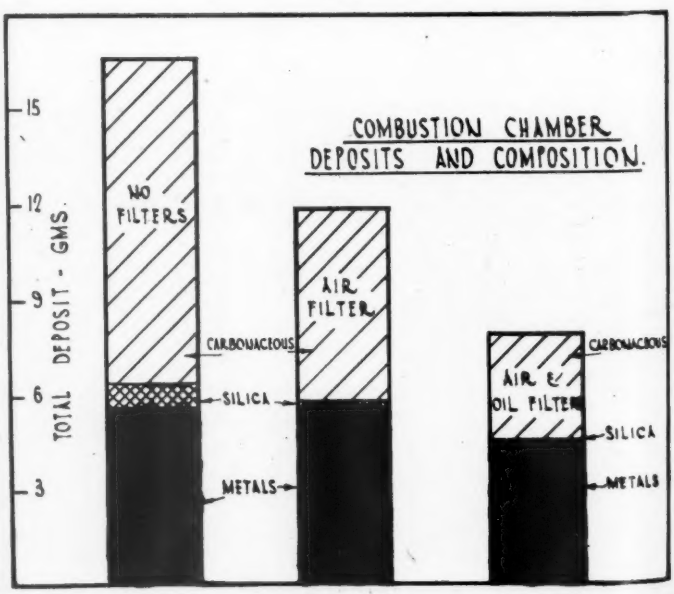


Diagram 13

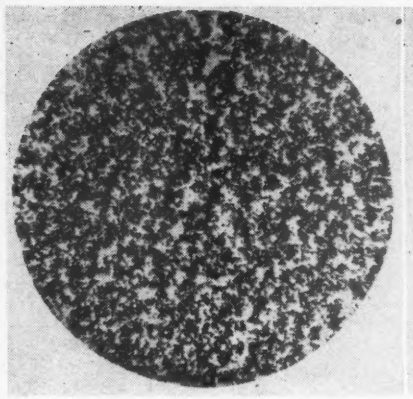


FIG. 9. After test with no filters.

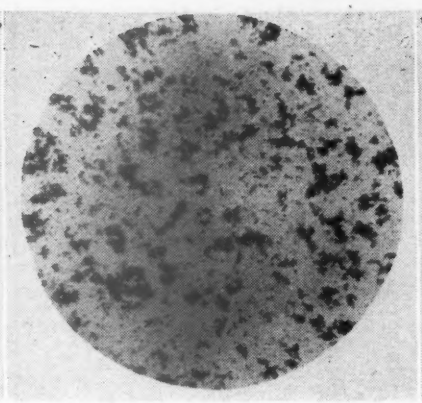


FIG. 10. After test with air filter.

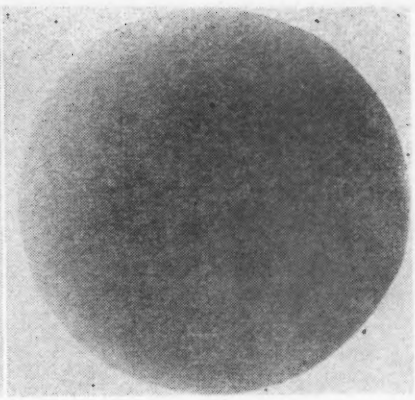


FIG. 11. After test with air and full flow oil filter.

Photomicrographs of used lubricating oil magnified about 250X.

TABLE 1. New and used oil analyses.

Property	New oil	Used oil (no filters)	Used oil (air filter)	Used oil (air and oil filters)
Specific gravity @ 60F	0.897	0.907	0.902	0.895
Redwood viscosity 70 F	1,565	1,090	1,156	1,410
140 F	185	178	168	168
200 F	65	67	65	63
Benzene insolubles, per cent	NIL	1.76	1.07	0.01
Per cent of non combustibles in benzene insolubles	NIL	69.3	40.2	†
Acidity, Mg. KOH/gm	NIL	0.09	0.12	0.32‡
Hard asphalt, per cent	NIL	0.28	0.18	0.02

† Quantity of benzene insolubles too small for accurate determination of non-combustibles.
‡ This figure is higher than in the preceding trials, due to less make-up oil being added.

duration was accepted as a basis for the comparative trials.

At the end of the test, surface profile graphs were again taken of the same components whose surfaces were recorded before assembling the engine. All other wearable components were either weighed or measured. The used No. 4 piston and ring assembly, center main and No. 4 big end bearing shells were again photographed.

Piston crown and combustion chamber deposits were weighed and analyzed. The used soil was examined in the laboratory and a photomicrograph taken to show its appearance.

The same test procedure was adopted for the second and third trials in order to maintain similar conditions. The air filter was fitted with a new element at the commencement of both of these tests.

What happens to an automobile engine when it is working in a dust atmosphere — without any filters — with an air filter — with air and oil filters?

Below, the results of some engine filter tests are discussed; the preceding discussion described the apparatus used and the way the tests were carried out. Fig. 3 shows extensive wear on the piston and ring faces. Also ring gap side clearance is very noticeable. With the air filter, Fig. 4, a definite improvement can be seen —the original machining marks still remain on the top land of the piston.

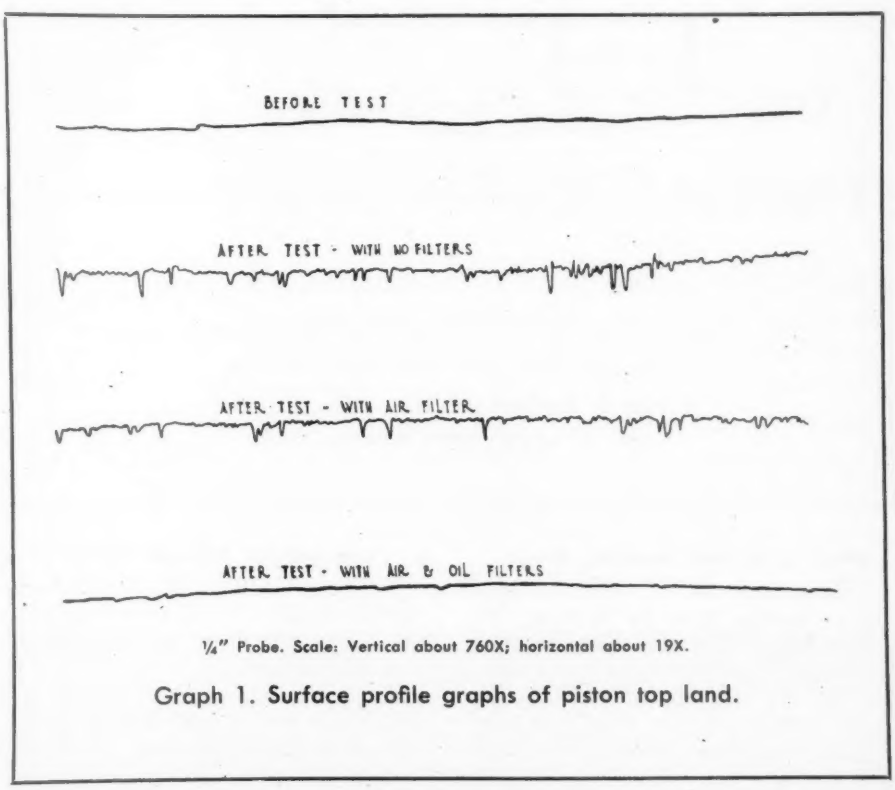
With air and oil filters, Fig. 5, it has been possible for carbon deposits and piston skirt lacquer to accumulate, both indicating absence of abrasive wear.

The actual piston top land wear and the loss in weight of the rings are shown in Diagrams 4 and 5.

Cylinder bore wear is shown in Diagram 6. It is interesting to note from these results that it is not only the air filter that influences the wear in this section of the engine; the influence of the oil filter, though smaller, is nevertheless substantial.

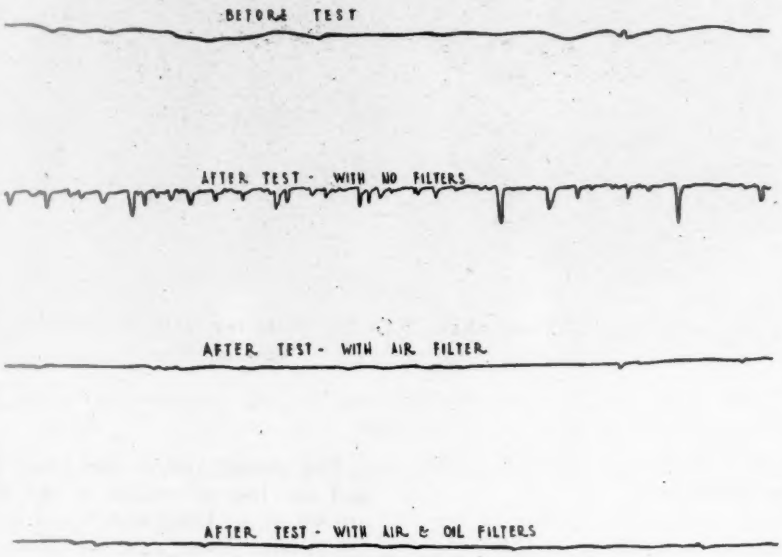
Valve Guide and Stem Wear

Diagram 7 shows the valve stem wear based on maximum reduction in diameter. Diagram 8 gives the respective loss in weight of valve guides. The valve guide wear figures should not be considered too accurate because it is difficult to remove the guides from the engine without tearing away some of the metal.



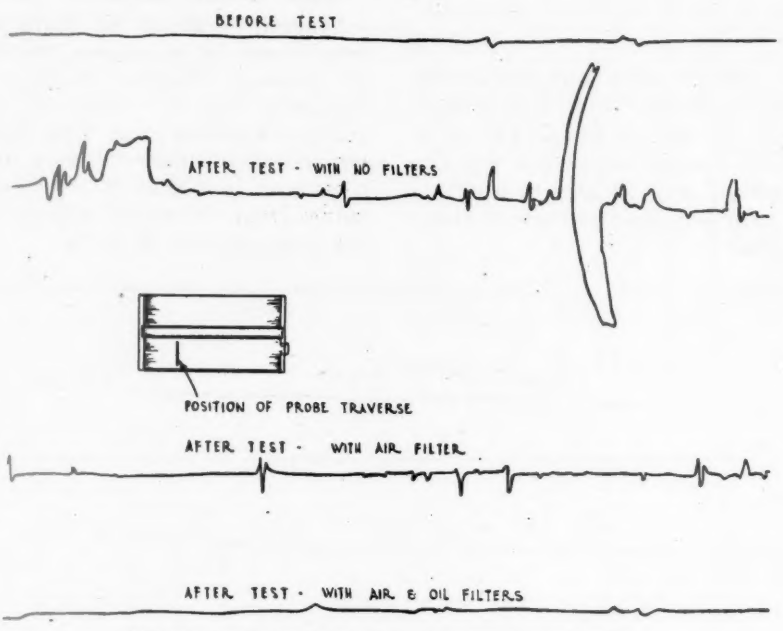
¼" Probe. Scale: Vertical about 760X; horizontal about 19X.

Graph 1. Surface profile graphs of piston top land.



¼" Probe. Scale: Vertical about 760X; horizontal about 19X.

Graph 2. Surface profile graphs of top piston ring face.


BEFORE TEST
AFTER TEST - WITH NO FILTERS
POSITION OF PROBE TRAVERSE
AFTER TEST - WITH AIR FILTER
AFTER TEST - WITH AIR & OIL FILTERS

¼" Probe. Scale: Vertical about 760X; horizontal about 19X.

Graph 3. Surface profile graphs of upper half of center main bearing shell.

Main and End Bearing Wear

Diagrams 9 and 10 show the saving in bearing wear by filtering the air intake, which indicates that airborne dust has little difficulty in finding its way into the sump. The results indicate clearly that both air and oil filters are essential for long bearing life.

Crankshaft Journal Wear

Diagram 11 shows that to prolong crankshaft life an oil filter becomes essential and that an air filter alone is inadequate.

The remaining article in this series will discuss the oil consumption, combustion chamber deposits, condition of used oil and the surface profile of the used engine component with and without filters.

The following illustrations and data show the effect of air and oil filtration on an automobile engine's combustion chamber deposits, lubricating oil properties and consumption as well as surface finish of wearable components.

Diagram 12 shows the amount of oil used for each trial. These results illustrate an indirect value of filtration, which is the result of lower cylinder and piston assembly wear.

Combustion Chamber Deposits and Composition

The deposits from the combustion chamber and piston crown are decreased by air and oil filtration. At least two factors bring about this situation. One is the direct action of the filters, for example the reduction in silica content when the air filter is fitted, and the other is the indirect effect of engine wear, which when reduced gives a lower oil consumption and thereby tends to decrease combustion chamber deposits. The respective influence of each factor was not determined.

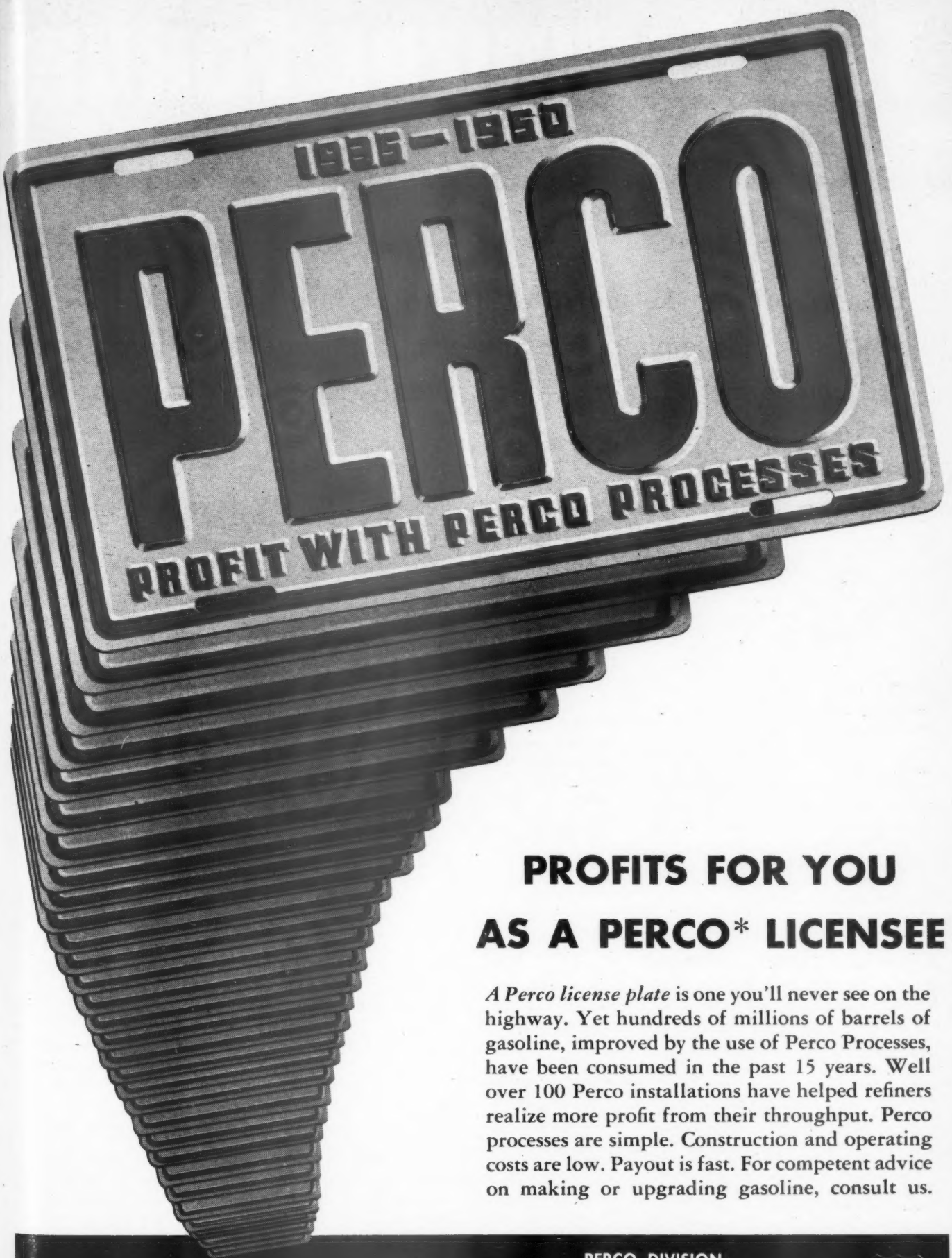
Condition of Used Oil

Table I gives the properties of the new and used oils. There are one or two aspects of the used oil properties that should be kept in mind. Firstly, engine wear assists crankcase dilution, causing oil viscosity reduction. This is particularly noticeable in the 'Used Oil—No Filters' column. Secondly, the less the engine wear, the smaller is the quantity of fresh oil added to the sump. This may account for the higher used oil acidity when filters are used.

The highly magnified surface contours (Graphs 1-3) show that wear and a rough surface go together and that there is a stage beyond which further wear does not produce a more jagged surface contour. These graphs illustrate clearly the advantage of filtering engine air and oil circuits.

The conclusions that can be drawn from these tests are that to prolong engine life it is vital to prevent foreign matter entering the air intake. At the same time it is almost as important to filter effectively the oil because there is ingress of impurities outside the protective scope of an air filter.

The air filter, as might be expected, has the greater influence on wear in the upper regions of the engine; the oil filter guards the life of crankcase components; both are necesary to keep wear within reasonable limits. ★ ★ ★



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THE TECHNICAL FORUM

Questions on the petroleum and natural gas industries' technology, chemistry, engineering, and operating problems are answered each month by widely recognized authorities.

Vanadium in Fuel Oil

Q **Could you supply any information or references on the effects of the vanadium content of "Bunker C" when used for firing furnaces of boilers? Consumers indicate that it has some deleterious effect on either the metal boiler parts or the refractories.**
—R. A. P.

A Vanadium content in "Bunker C" causes rapid failure in alloy containing nickel where the temperature of the metal is above 1200 F and where the vanadium bearing ash comes in contact with the metal. It is believed that a "leaching" of the nickel occurs. We have no knowledge of where vanadium content was felt to be the cause of refractory failure.

The Asiatic Petroleum Corporation has a great deal of experience with this problem in its Curacao operations.
—Frank H. Praeger.

Hydrogen Sulfide Removal

Q **We have the immediate problem of removing 95 per cent of the hydrogen sulfide in our 7,000,000 cu ft per day manufactured gas by a process other than the dry box method of iron oxide sponge now employed. This latter process may be utilized to remove the traces of hydrogen sulfide, the bulk of the purification being handled by the installation of new process equipment. An analysis of our gas is attached.**

The literature on sodium carbonate solution absorption and desorption (utilizing either steam or air for regeneration) indicates this process would fit into our plant process most conveniently, economic considerations being equal.

We are specifically interested in knowing whether or not the forum would agree such a process would be satisfactory for use in our gas containing six to seven volume per cent carbon dioxide, and if other processes would be economically preferable to sodium carbonate scrubbing for the small 7,000,000 cu ft per day gas rate and the 200 to 500 grains of hydrogen sulfide content. **—P. C. Joy.**

A The suggestion that the present dry box iron oxide purification method, as noted above, be replaced by the sodium carbonate absorption and desorption process, also known as the "Seaboard Process", reflects the trend that became active with the introduction of this and other liquid purification methods. Within five years after the introduction of the "Seaboard Process" and its description in 1921 by F. W. Sperr, Jr., of the Koppers Company[1], under whose direction it was developed, over 40 such plants were installed in America, Europe, and Japan. The use of "Seaboard Process" as suggested proved successful on a commercial scale in the gas industry.

Before converting to a combination of dry box and liquid purification installation, a study should be made of existing dry box equipment and the availability of purification materials. For the purification of 7,000,000 cu ft of manufactured gas daily containing 200 to 500 grains of hydrogen sulfide, it is very possible that, with certain improvements, existing facilities may be employed satisfactorily. First, if revivification in place is not used presently, this should be investigated. This may be accomplished in two ways: First, a small amount of air (about 2 per cent) may be introduced into the gas ahead of the purifiers. Second, air may be passed through a box of fouled oxide after it has been shut off from the rest of the purifying system.

Each of these methods has its advantages and disadvantages, which are discussed by Dunkley and Barnes[2].

Should the cost of iron oxide purifying material be a deciding factor, the possibility of using natural ores if available, or the manufacture of such materials in Honolulu should be investigated. Dotterweich and Huff[3] have proposed a method for iron oxide evaluation and commented on the various types used and their manufacture.

After a study of the dry box method, as suggested above, should the decision to install liquid purification be reached, the carbonate method should be satisfactory; however, the dry box

THIS IS FOR YOU

This Forum is a meeting place each month for engineers, technologists, students, operators, and all others interested, where each may profit not only by answers to his own knotty questions, but learn as well by reading the answers to the questions of others in the industry, answers submitted by the leading scientists and engineers in the world of oil and gas.

Address all questions to **Technical Forum Editor, Box 1589, Dallas 1, Texas.** Send them in right away while you think of it.

Gas Analysis

Analysis, Vol. %:

CO_2	6.4
C_nH_{2n}	4.4
O_2	0.4
CO	15.8
H_2	44.8
CH_4	20.3
C_2H_6	—
N_2 (diff)	7.9
Calculated Btu/cf	513
Calculated Sp. Gr.	0.544

Organic Sulfur
30 to 50 grains/100 cu ft
Hydrogen Sulfide
200 to 500 grains/100 cu ft

must be used to complete the purification. The 7 per cent of carbon dioxide, a portion of which will be removed with the hydrogen sulfide, will have some effect upon the absorptive capacity of the sodium carbonate solution. The equilibrium relations between hydrogen sulfide and carbon dioxide, and solutions of alkali carbonates, bicarbonates and hydrosulfides have been investigated and reported by Dryden[4].

References

1. Sperr, F. W., Jr. Progress in Liquid Purification. Proc. A.G.A., Tech. Sect., 1923, 1200-31.
2. Dunkley and Barnes. Gas Purification in the Medium Size Gas Plant of Illinois. Bulletin 25, Cooperative Mining Series, State Geological Survey, Urbana, 1920.
3. Dotterweich and Huff. Proc. A.G.A., Tech. Sect., 1938, 699-713.
4. Dryden, G. C., Soc. Chem. Ind. Jour., Vol. 66, page 59-64. Feb. 1947.

—Frank H. Dotterweich.

Cleaning Heat Exchangers

Q Please give me information, with references, on the use of solvents and possibly combustion, for cleaning heat exchanger tube bundles subject to shell side fouling with carbonaceous and tarry deposits.—E. J. S.

A The cleaning methods for the shell side of tubular heat exchangers fall into two general classes. The first class consists of those methods that perform the cleaning in place by means of the circulation of a cleaning solution, which chemically and/or physically removed the fouling material. The second class includes all those methods whereby equipment is partially or wholly dismantled and the fouling material is removed by chemical, physical, or purely mechanical means. In order to determine the adaptability of the in-place methods, a laboratory examination of the fouling materials must be made. Following the laboratory determinations, a plant test under close supervision should then be made.

In order that equipment be cleaned in place, the fouling material must be removed by any one or a combination of the following methods:

1. Chemical reaction with acidic or alkaline solution.
2. Solution of a portion (the binder) of the fouling material in the cleaning fluid permitting the undissolved portion to be flushed out.
3. Suspension of the fouling agent.
4. Complete solution of the fouling agent or the binder in an organic solvent.

The last three methods mentioned above would be those most common to the removal of carbonaceous or tarry deposits.

In-place methods of cleaning the shell side of tubular heat exchangers offer the following advantages: Reduction in downtime, elimination of dismantling costs and dangers, only method for non-removable tube bunbles, thorough and uniform cleaning, no material loss or scoring. The principal disadvantage of solvent in-place cleaning is the uncertainty of results, and in order to insure complete cleaning, it may be necessary to remove the bundle and immerse it in a tank of suitable solvent. The immersion method along with several recommended solvents is described by Butler and McCurdy in the accompanying reference.

Cleaning by combustion is not considered good practice except in very special cases where an accurate temperature control can be achieved. In those cases, close control of the oxygen in the combustion mixture must be maintained in order to safeguard equipment from the dangers of excessive temperatures. Sand blasting is a common method of removing carbonaceous deposits.

The following is a group of recent articles pertaining to shell side maintenance of tubular heat exchangers:

Butler, R. C., and McCurdy, W. N., "Fouling Rates in Heat Exchangers," Oil and Gas Journal, December 23, 1948, Page 67.

Dougherty, P. F., and Brooks, C. H., "Cleaning Tubular Heat Exchangers," Oil and Gas Journal, December 2, 1948, Page 83.

Housman, J. G., "Maintenance of Tubular Heat Exchangers." Petroleum Processing, July, 1947, Page 534.

Loucks, C. M., and Groom, C. H., "Chemical Cleaning of Heat Exchanger Equipment." Oil and Gas Journal, December 23, 1948, Page 66.

Weiland, J. H., et al, "Rates of Fouling and Cleaning of Unfired Heat-Exchanger Equipment," Oil and Gas Journal, December 23, 1948, Page 64.

—R. L. Purvin.

Sodium Sulfide Recovery

Q What would be the chief problems connected with passing hydrogen sulfide gas from a girbotol unit through spent caustic, and from that producing sodium salts for the market?
A. W. R.

A The chief technical problems would be contamination of the product mixture of sodium sulfate and sodium sulfide. The spent caustic would probably contribute oil contamination while the hydrogen sulfide gas would probably contain traces of lower mercaptans, which the spent caustic would neutralize. Traces of elemental oxygen entering through leaks or possibly dissolved in the caustic would react with the hydrogen sulfide liberating elemental sulfur. The extreme toxicity of hydrogen sulfide would require adequate safety provisions. The sodium sulfate-sodium sulfide mixture after evaporation to the solid form might be salable to kraft paper mills.

It is questionable whether investment of new money for facilities for this operation can be justified unless firm commitments for the product obtained would show an adequate payout.

—James H. Boyd.

Natural Gas Compression Thermodynamics

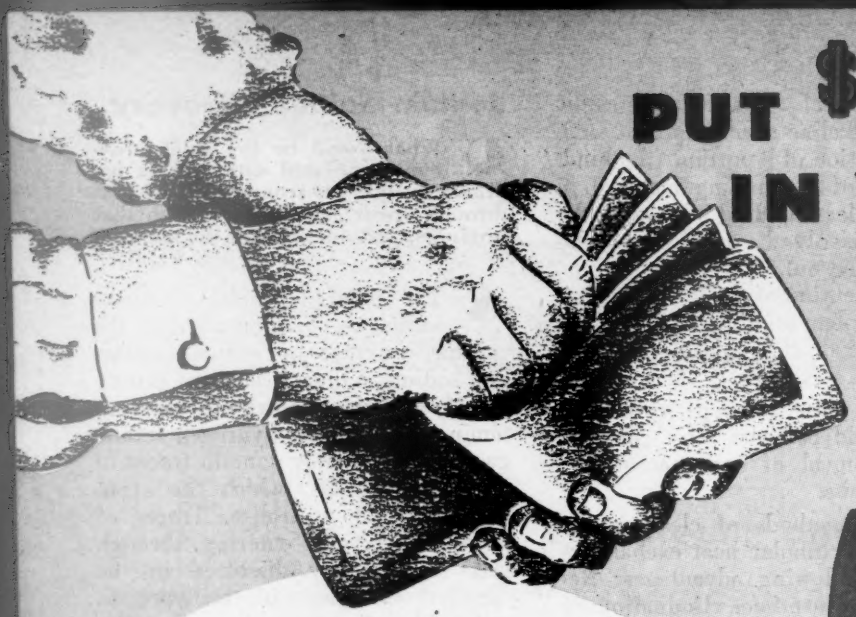
Q What is a good reference book on the thermodynamics of natural gas compression? I would like a book or manual that gives thermodynamic properties of the various gases that are most commonly found in natural gas.
J. F. Todd.

A As far as we know there is no good reference book devoted specifically to the subject of the thermodynamics of natural gas compression. However, any standard thermodynamics text such as "Chemical Engineering Thermodynamics", Dodge, McGraw-Hill, discusses the thermodynamics of compression. These texts usually cover the subjects of compressor work, effect of clearance, number of stages, inner-stage pressures and inner-stage coolers.

Thermodynamic properties of the various gases most commonly found in natural gas may be found in: (1) The Petroleum Engineer's Continuous Tables; (2) Technical Manual (Fifth Edition) for the Natural Gasoline and Cycling Industries; and (3) The Chemical Engineering Handbook, Perry, McGraw-Hill. In addition, the Clark Compressor Company publishes various bulletins on the thermodynamic properties of natural gas components.

G. L. Farrar,
A. M. Platt.

* * *



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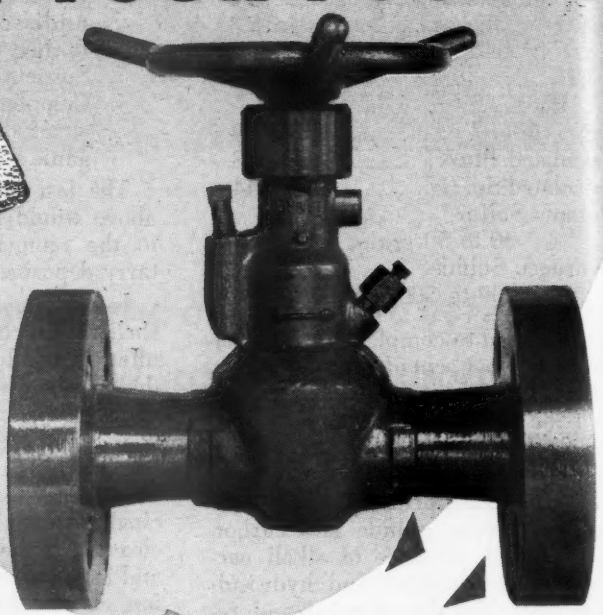

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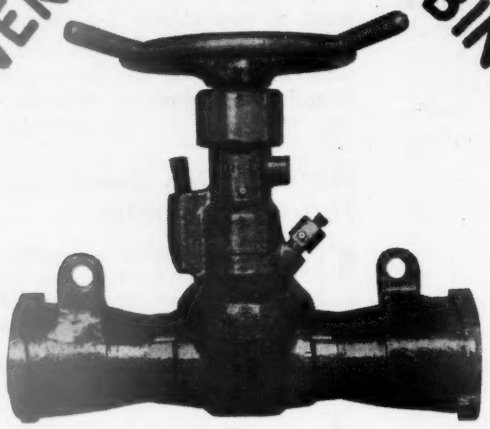

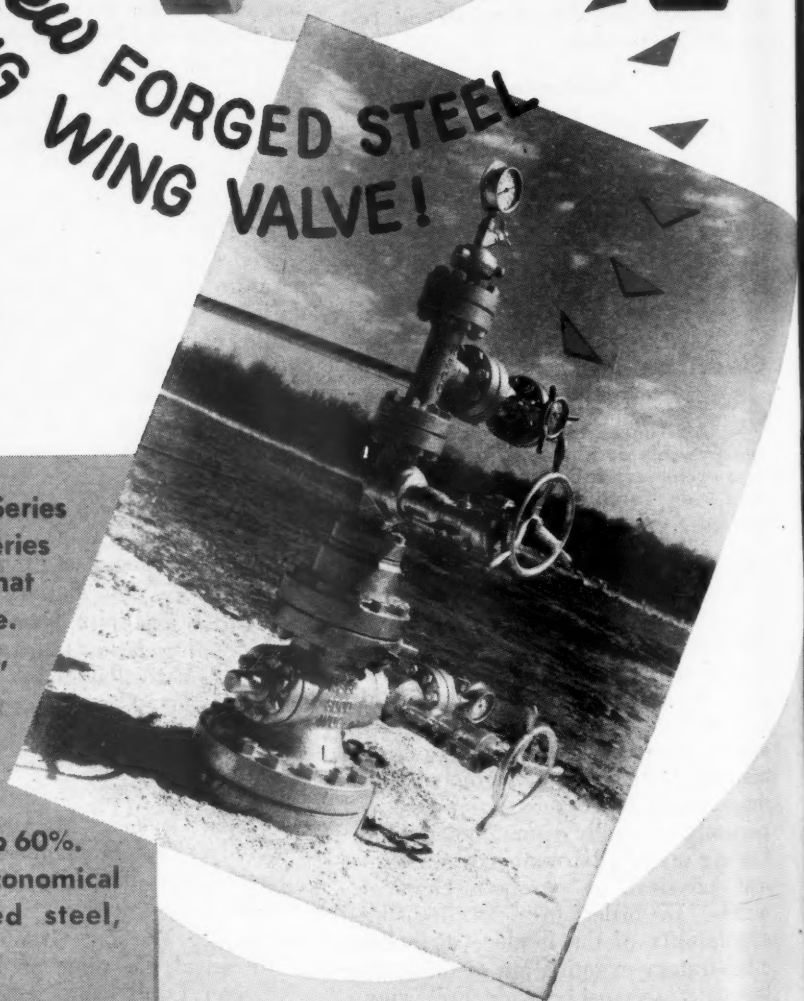

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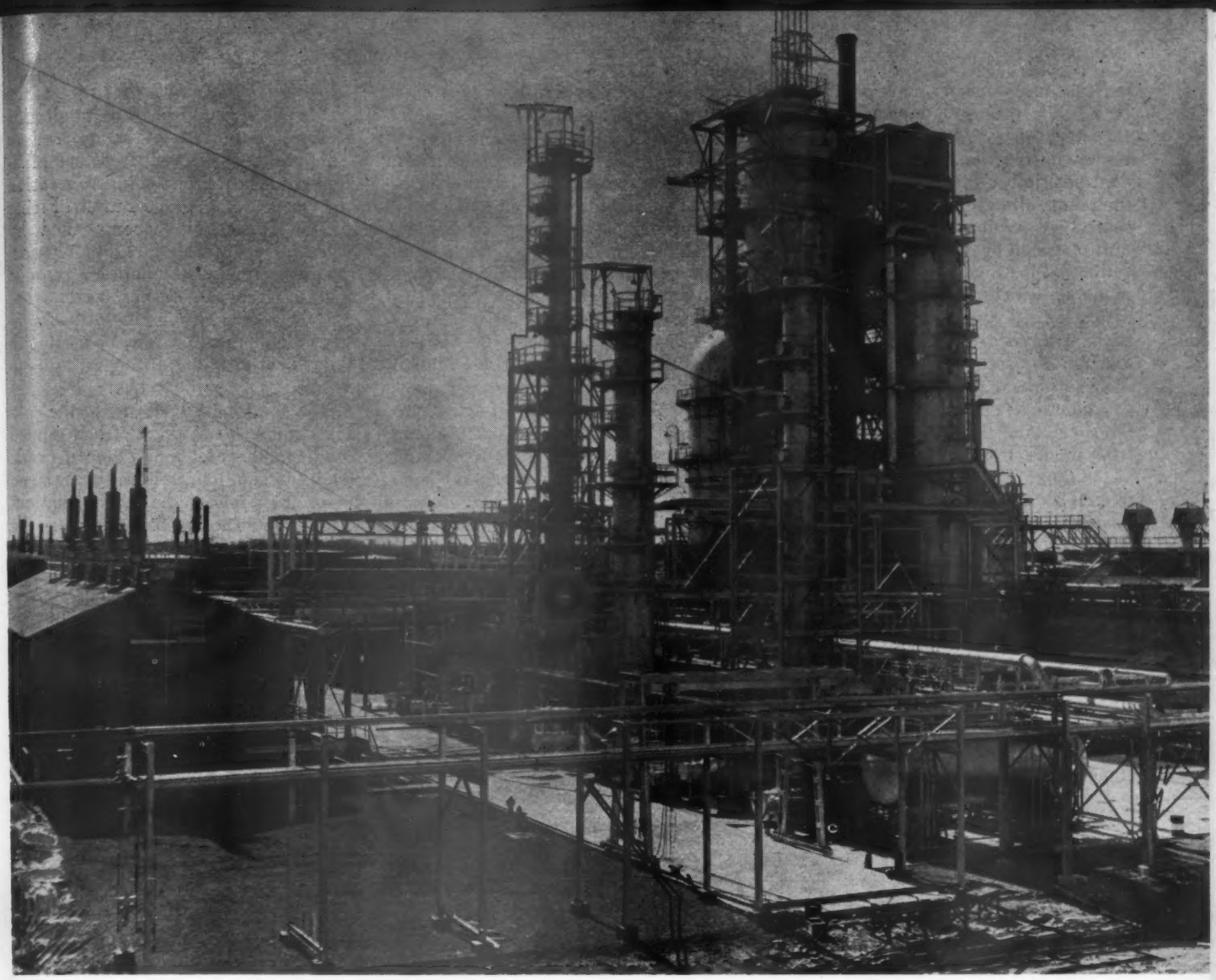


Catalytic cracker columns and compressor building (left), Sohio refinery, Lima, Ohio.

P 710.1

Modernization of Ohio Refinery Made Around Catalytic Cracker and Coke Unit

J. C. ALBRIGHT

THE Standard Oil Company of Ohio began in 1948 a program of modernization in its refinery at Lima so that the company would be in a much better position to supply a superior quality of products in quantity for motorized equipment and other types of machines. Modernization of this refinery includes facilities from crude storage to loading racks, with processing equipment designed to eliminate industrial fuel oil largely while increasing substantially the manufacture of gasoline. The ultimate completion of this multi-million dollar project will not be accomplished until mid-1950, but some of the major units are now on stream and producing the anticipated commodities available in crude petroleum.

Among the units placed in operation recently is the Universal Oil Products Company fluid catalytic cracking plant which has a processing capacity of 16,000 bbl of mixed gas oil daily. The charging stock is obtained from two sources in approximately equal volumes; from the pipe still fractionation of Illinois Pipe Line crude, and from the crude and delayed coking unit, designed by M. W. Kellogg Company. This latter unit is capable of processing sour West Texas crude from the Slaughter Field together with a reduced bottoms from the existing topping plant.

EXCLUSIVE

In order to obtain a clear picture of the catalytic cracking plant, perhaps the production of gas oils should be shown first so that the tie-in between

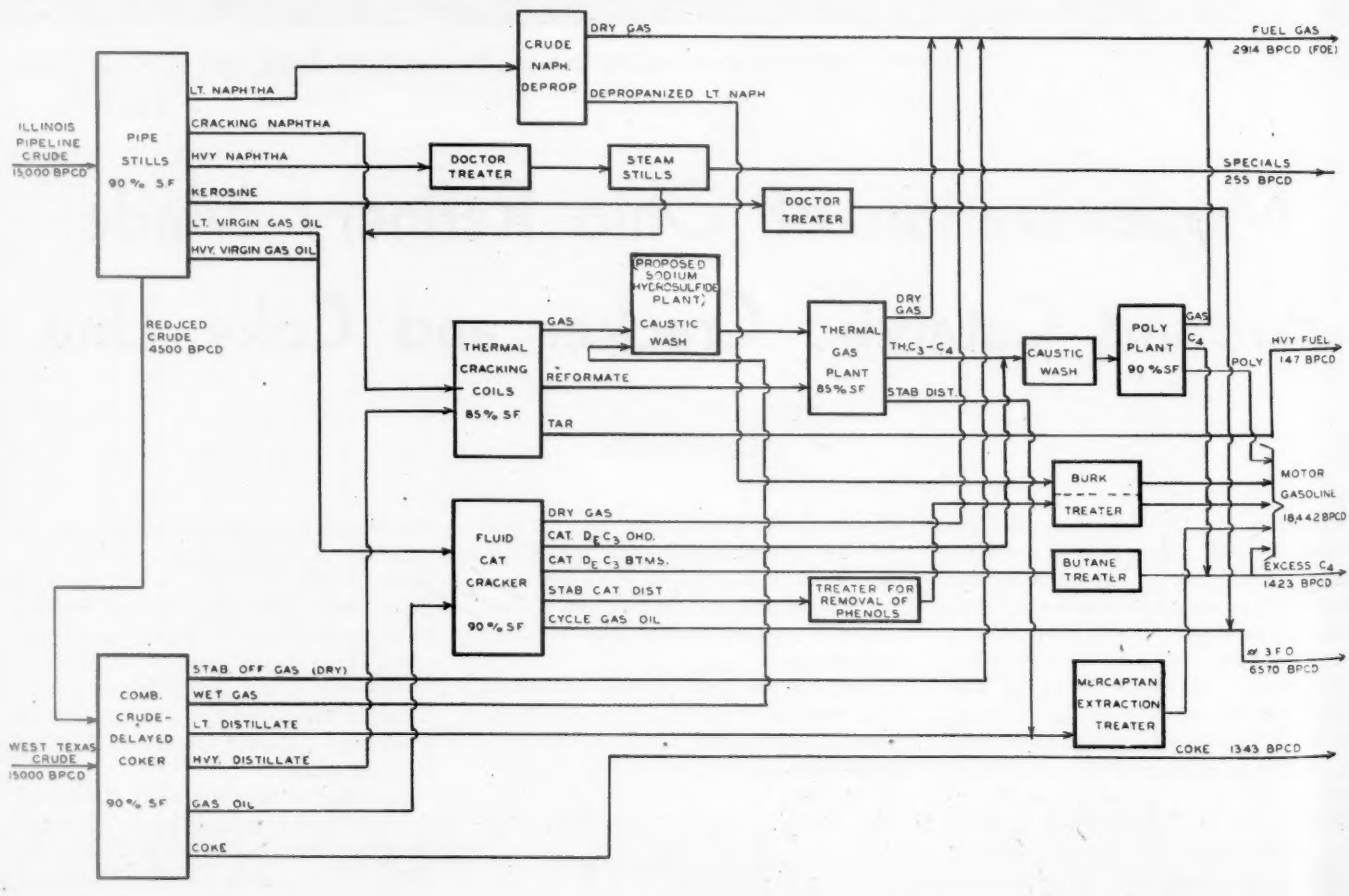
existing units and the new plants can be visualized more completely. All of the new operating units and those under construction have a certain relevant position so that the new units and the plants already in place may be operated in sequence. The distillation unit operated to process what is called "Illinois Pipe Line Crude" is a topping plant in which the fresh Mid-Continent crude is split into desired fractions with controlled boiling ranges, leaving a residue as reduced crude, which is blended with other material as a charge to the delayed coking unit. Overhead and side streams removed from the fractionator, or main column in the topping plant are separated and treated as products having a definite purpose. Overhead light naphthas are depropanized, treated and debutanized for a low end point gasoline blending stock. Heavier naphtha is produced as a blending product to be used, with coker naphtha, as the charge to the thermal reformer, one of the original units operating before modernization and expansion of facilities at Lima were started. Light and heavy virgin oils are produced and blended with coker gas oil as the normal charge to the fluid catalytic cracking unit.

The Kellogg delayed coking unit replaces a battery of batch type shell coking ovens and processes a total charge of 19,500 bbl of blended topped crude and fresh Slaughter sour oil from West Texas. The 15,000 bbl of West Texas crude pumped to the main column of the coking plant follows through several heat interchangers on tower product streams to reduce the temperature of these products and to soak up as much waste heat as possible before entering the crude heater and thence into the fractionating column. After flowing through the interchanger on the column overhead stream and a unit on one of the side streams, the crude enters a Petroleum Rectifying desalting unit and a desalted crude surge drum. From this point it normally follows through various other interchangers and to the heater and fractionator. An alternate operation is provided so that the crude may be diverted to the existing topping unit if desired.

Operating on a design schedule, the preheated crude may be split so that a portion enters the base of the main column along with the Illinois Pipe Line reduced crude from the topping plant, while the remainder flows directly to the combination crude oil and delayed coker furnace. This furnace is built with six complete circuits, two radiant sections to process the crude charge and four radiant circuits engineered for the coking operation. The total heat release of this combination crude heater and coking operation furnace is 114,000,000 Btu/hr. Firing of the furnace is accomplished by using either liquid—fuel oil—or process gas for fuel, as the floor is equipped with two separate burner systems that may be used individually as fuel supplies dictate, or they may be used with both fuels to maintain operating conditions.

The combination charge to the coking drums, made up of fresh topped crude in the unit and reduced crude from outside operations, is pumped from the base of the main fractionating column to the furnace where the charge is split into four equal streams to flow through the four radiant circuits of the heater. The material in process is collected from the outlet of the furnace circuits into two equal streams and transferred to a common line connected to both coking drums. These drums have a diameter of 17½ ft and a straight wall height of 70 ft, each drum built for a coke capacity of 400 tons, and operate on a cycle of 24 hours on stream. The pressure at which the drums are operated is governed by the V.C.M. of the coke de-

Flow diagram of Sohio's modernized refinery.



sired, ranging from a low of 20 psig to a high of 40 psig. The drums are equipped with the conventional Worthington hydraulic coke cutting equipment, but a novel feature of the plant consists of a different blow-down system developed by Sohio engineers. This system includes facilities for recovering the wax tailings during the steaming operation of the coke drums so that commodities may be salvaged that otherwise might be wasted.

Vaporized products of the coking operation flow from the drums to the base of the main fractionating column where they enter through a nozzle opposite the connection through which the Illinois Pipe Line reduced crude is introduced into the column. Instead of constructing two fractionating columns, one for crude products and one for coking operation cracked products, Sohio employs only one column, which handles the entire vapor stream of both operations. Overhead vapors from the main column, partially cooled by interchange with the cold West Texas charge flows immediately through a water serviced shell and tube condenser and into the column reflux drum. Uncondensed gases released from the reflux drum are compressed by two 400 hp angle-type compressors to 150 psig where the gas is contacted with the liquid product from the reflux drum and cooled. Gas is then separated in a gas separation drum and piped to the refinery vapor recovery system and an absorber for recovery of desired hydrocarbons. Liquids accumulated in the gas separation drum are pumped to a 24 plate stabilizer, operating at 345 psig to produce a stabilized 300 ep gasoline. Overhead vapors from the stabilizer are piped to the fuel system and burning lines of the refinery. By the use of only one main fractionating column to process the various fractions, the products are a composite mixture of straight run and cracked material.

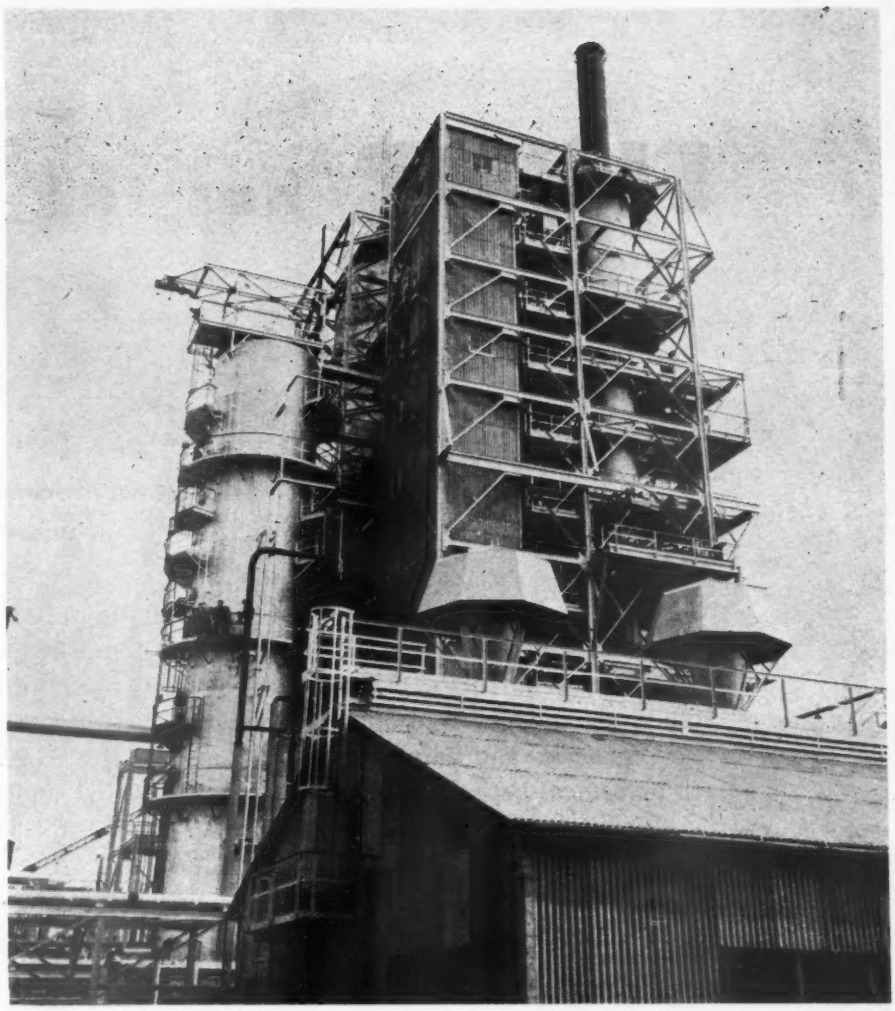
The following tabulation shows the combined yields of the unit when 15,000 bbl per day of Slaughter crude and 4500 bbl per day of Illinois reduced crude are charged to the coking unit:

Products	No. per hr.	Bbl per day	Wt. per cent	Vol. per cent
Stab. off gas	3,335	.....	1.3	....
Wet gas to absorber	7,070	.....	2.8	....
Stabil. 300 ep gaso...	56,135	4,770	....	24.4
290-475 heav. naph..	43,100	3,695	....	19.0
Gas oil	121,000	9,365	....	48.0
Coke	25,800	.....	10.3	....
		17,830		91.4

Facilities for rapid handling of removed coke are built into the coker unit so that both motorized trucks and gondola railroad cars can be spotted beneath the base of either drum to receive the coke without excess handling. The concrete foundation of the coker installation and the paving beneath the area have been designed to support heavy equipment. Trucks that are employed to move the coke from the drum outlets in smaller lots are of the conventional road building type, commonly called "Euchs" in the parlance of those familiar with hauling heavy concentrated loads rapidly. Spotting of empty and filled railroad gondolas is simplified by the use of double and single line cable spools, power driven, so that the cars can be moved from the local plant spur and taken away from the coke drums before switching to rail yards with a 50-ton Diesel electric locomotive.

Specially designed movable platforms are installed to handle the coker bottom heads with hydraulic apparatus for lowering and raising the plates after unbolting and when the drum has been cleaned and ready to be placed in service again. Pneumatic wrenches are mounted on a circular track under the drums so they can easily be pulled in position for "hot nutting" and for closing the drums after cleaning out. These pneumatic wrenches are built with adjustable torsion so that each nut can be run up in place with the same pressure against the head as the others in the series. The superstructure above the coking drums is designed with sufficient height that a full cut can be made to the bottom of the drum in a single continuous operation. Instead of the conventional series of stairways for men to mount to the top platform of the coke drums, Sohio has an electrically operated elevator with the cage large enough to transport both men and materials for operation and the turnaround. As the coke falls from the drums under the impact of the hydraulic cutting tools, the fines and breeze are separated from the water with a Dorr-Thickener unit to prevent waste of a product and to condition the water for reuse, if this is required.

Preventive maintenance is built into the coker unit, as it is designed to operate continuously on high sulfur,



Enclosed elevator shaft. Fluid unit is in center.

PHOTOS BY JOHN F. TRAUGER, STANDARD OIL COMPANY (OHIO).

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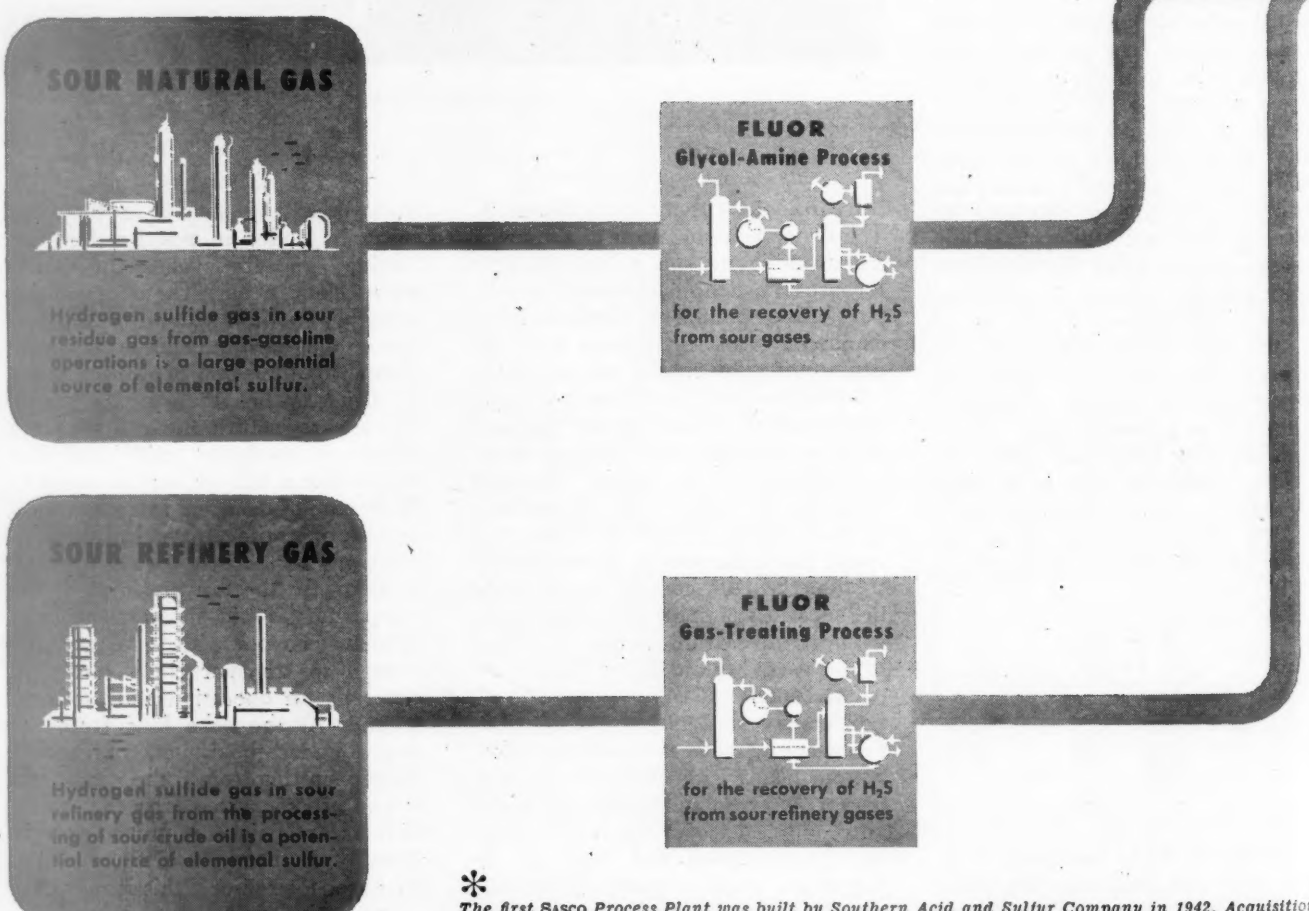
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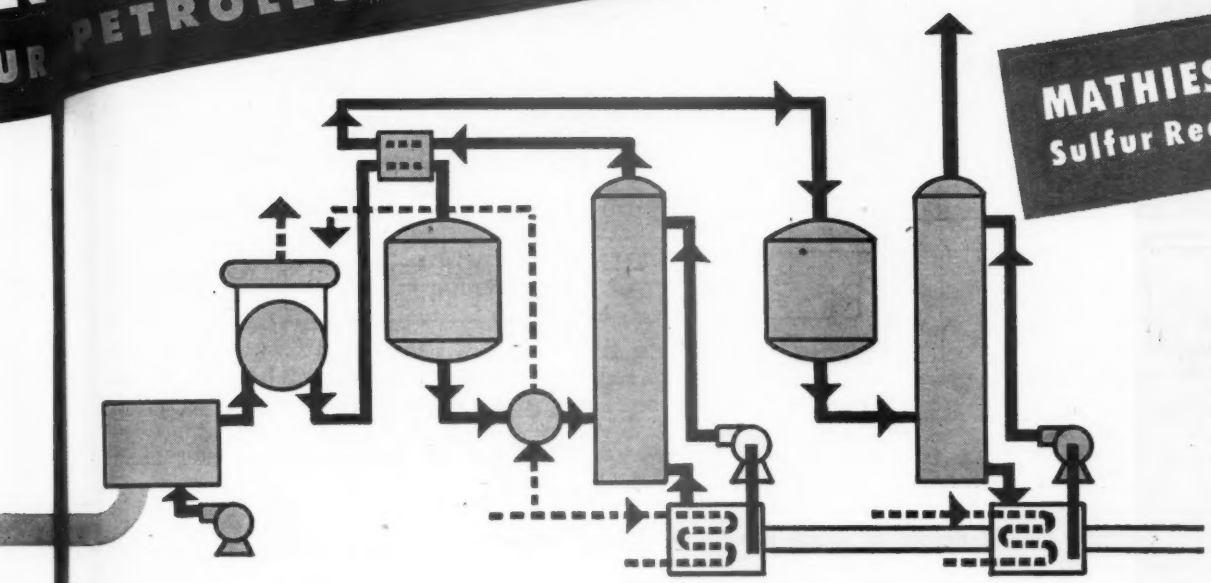

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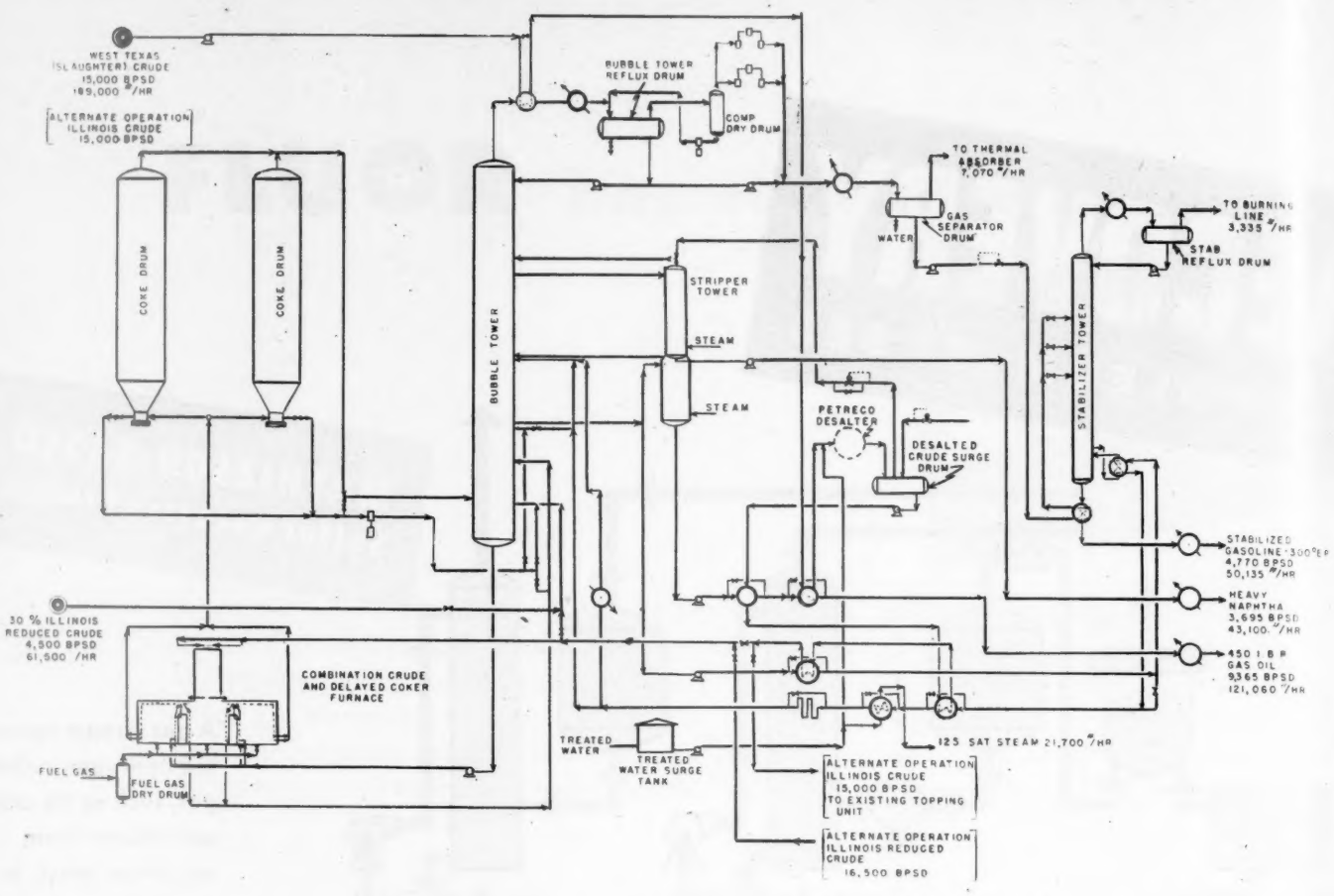

WEST TEXAS (SLAUGHTER) CRUDE 15,000 BPSD 189,000 #/HR
ALTERNATE OPERATION ILLINOIS CRUDE 15,000 BPSD
BUBBLE TOWER REFLUX DRUM
COMP DRY DRUM
TO THERMAL ABSORBER 7,070 #/HR
GAS SEPARATOR DRUM
WATER
TO BURNING LINE 3,335 #/HR
STAB REFLUX DRUM
COKE DRUM
COKE DRUM
BUBBLE TOWER
STRIPPER TOWER
STEAM
STEAM
PETRECO DESALTER
DESALTED CRUDE SURGE DRUM
STABILIZER TOWER
STABILIZED GASOLINE 300°EP 4,770 BPSD 50,135 #/HR
HEAVY NAPHTHA 3,695 BPSD 43,100 #/HR
450 I.B.P. GAS OIL 9,365 BPSD 121,060 #/HR
30 % ILLINOIS REDUCED CRUDE 4,500 BPSD 61,500 /HR
COMBINATION CRUDE AND DELAYED COKER FURNACE
FUEL GAS
FUEL GAS DRY DRUM
TREATED WATER
TREATED WATER SURGE TANK
125 SAT STEAM 21,700 #/HR
ALTERNATE OPERATION ILLINOIS CRUDE 15,000 BPSD TO EXISTING TOPPING UNIT
ALTERNATE OPERATION ILLINOIS REDUCED CRUDE 16,500 BPSD

Flow diagram of crude coke unit at Lima refinery.

sour, West Texas crudes. Various types of alloys were selected for a definite purpose under design operating conditions. When furnace tubes are to be subjected to a minimum temperature of of 600 F, seven per cent chrome with one per cent molybdenum alloy tubes are installed. All tube header boxes connected to chrome-moly tubes are 9 per cent chrome, and the coke drums themselves are full lined with 5/64 in. thick, 11-13 per cent chrome sheets. The lower section of the main fractionating column, in the area where temperatures are consistently above 525 F, is also lined with 5/32 in., 11-13 per cent chrome. Piping in the unit which falls in the operating cycle with temperatures above 550 F are 4-6 chrome molybdenum. The corrosion allowance for all carbon steel drums was set at $\frac{3}{8}$th of an inch. The reflux drum installed in the overhead vapor line of the main column is a horizontal vessel having the lower half of the shell lined with monel metal. The water drawoff pot and connecting piping of this part of the system are fashioned from solid monel metal. Pumps handling commodities in the coker unit are trimmed with suitable alloys for the conditions under which they operate so that long life and a minimum down-time are assured. To provide easy and expeditious handling of exchanger bundles at grade level, a Gantry crane was installed, and trolley beams are provided in pump and compressor rooms, and over all exchangers above grade to remove and replace this type of equipment during turnarounds and metal inspections.

With a supply of virgin gas oil resulting from topping the Illinois Pipe Line crude, and the cracked gas oil obtained by coking topped fuel oil and West Texas, Slaughter crude, the fluid catalytic cracker is charged with a uniform feed of 16,000 bbl per day. This fluid cracker constructed by the Arthur G. McKee Company, is the result of intensive examination of other existing plants of similar basic design, and incorporates features found in those plants, and other features developed recently by Sohio engineers, which expedite maintenance and provide a greater flexibility.

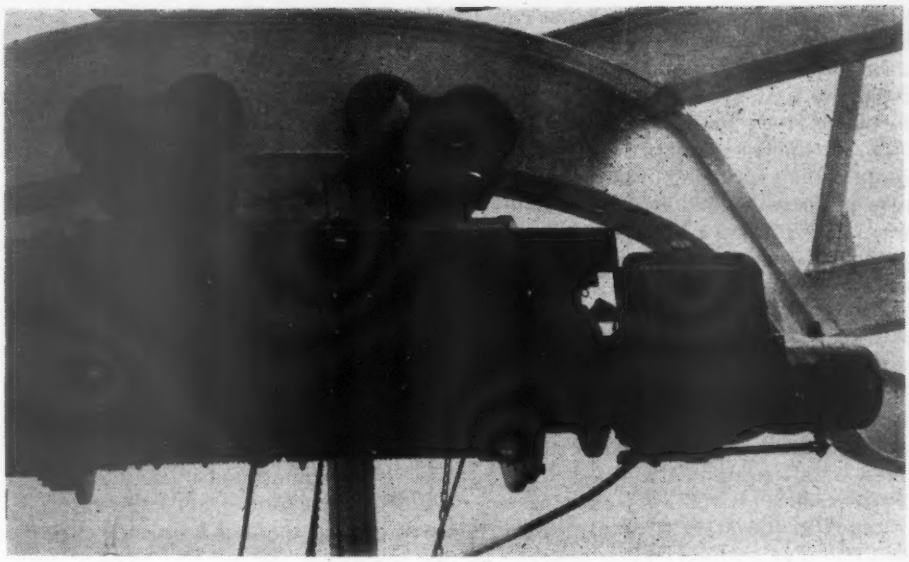
When laying out the design of the unit, overall height was considered, so the reactor is placed above but offset from the regenerator. The reactor is a swedged vessel having a top section inside diameter of 26 ft and a bottom section diameter of 23 ft, 6 in. The total straight height is 43 ft and contains 5 single stage cyclones. The regenerator has an inside diameter of 34 ft and a straight height of 44 ft equipped with a total of 12 cyclones in two stages. The catalyst stripper is placed within the bottom section of the reactor, so as to decrease the total height of the complete structure, and is equipped with flapper doors so the catalyst can flow from the reactor to the stripper under a slight differential pressure. These doors are placed at three elevations, each elevation fitted with 10 doors each. Twelve vertical slots near the top of the stripper permit adjustment of the catalyst level so as to provide the required catalyst level for various space velocities.

All of the products leaving the catalyst reactor enters the main fractionating column which has an inside diameter of 16 ft and a straight height of 95 ft containing 20 bubble trays and 7-disc and doughnut trays. Overhead uncondensed vapors are compressed with four 600 hp Ingersoll-Rand units in two stages to recover all of the desirable fractions in the cracked product. To supply the required volume of air to the unit (47,000 cfm), two 3000 hp electric motor driven turbo-compressors are operated which turn over at 5100 rpm.

Yields of the plants are as follows:

Products	Yield
Gasoline	47.5 vol per cent
Gasoils	34.2 vol per cent
Butane	13.9 vol per cent
C_3 & lighter	7.7 wt per cent
Coke	7.4 wt per cent

As the operation of a catalytic cracker depends largely upon accessibility for efficiency and short down time during a turnaround, Sohio engineers investigated thoroughly all angles of the problem before the plot plan was laid out. The Lima plant is situated in a north and south direction with the equipment placed between a system of 5 north and south access roadways, one roadway in each battery limit line and three through the center of the unit. The width of each of these access roadways is 24 ft, with vertical clearance at not less than 21 ft. All overhead piping crossing roadways is at right angles to the roads and the width of the roads and the vertical clearance were specified so that motor cranes with long boom sections might pass easily through the area with a maximum degree of maneuverability. The unit itself, and the roadways established for service are laid out so that each roadway has a specific usefulness. For example, the roadway on the west unit boundary line is used only to service the blower building. Ease of access to the blower building for the purpose of removing major units is provided by building the west wall, adjacent to the service roadway, so that the entire wall section can be removed quickly and easily. The next roadway to the east, running through the unit itself, is used only to service and handle equipment on the main catalytic structure. The third roadway to the east is used on a turnaround to service, remove and replace the pumps installed in the gas concentration section and the pumps installed inside the pump house. The fourth roadway to the east is spanned by a movable Gantry crane, which is used to service the exchangers in the gas concentration plant. These exchangers are installed at grade and the Gantry crane spans the entire 24 ft roadway, and has adequate head clearance for trucks to move freely. The exchanger bundles can be removed and placed on the flat bed of a truck for removal to the shops for cleaning, as these units are not to be repaired or cleaned on the ground in the plant. The exchangers and cooling equipment in overhead service are installed in supporting structures and are fitted with separate overhead trolleys and are equipped with block valves so that any unit can be cut out of service when necessary. Flange blanks are provided so that leaks are prevented, and the fouling factor of the exchanger batteries is high enough that any one of the units can be cleaned while the plant is in operation. By building into the plant these factors, the exchangers can be serviced in sequence without waiting for a turnaround to make these repairs, which lowers the labor load and reduces down-time appreciably. The overhead trolley beams also



Electric hoist and trolley beam.

Cat cracker showing elevator, left, flue gas stack, right, with muffler and pressure expansion chamber. Note electric hoist.

span the roadway so that bundles can be lowered directly to a truck for shipment to the shops for servicing away from the unit area. The roadway on the east battery limit parallels the east side of the gas compressor engine room and all servicing of the compressors is accomplished from this roadway. This roadway is entirely free of overhead lines so that it will be possible to operate long booms on mobile cranes to remove and service, as well as replace, any major part of the equipment, or heavy piping from the main structure, which cannot be handled by the structure elevator or the trolleys and hoists installed for relatively small equipment.

An electric driven Otis elevator is installed in the main structure of the catalytic plant, which travels approximately to the top of the main structure and has automatic and selective stops for the 10 different operating platforms. It was designed and installed not only for the convenience of the operators on routine inspection trips, but as a service elevator to lift and lower men and materials in large numbers and quantities. The cage floor has an area of approximately 8 ft wide by 12 ft long and has a lifting capacity of three and one-half tons. At all levels, except at ground level, the elevator doors open onto the working platforms, and the doors are split in the horizontal middle section so that one half raises while another lowers, providing full opening without obstructions. At the ground level, the doors open in a similar manner but facing the roadway so that trucks can back up to load or unload any material required on the unit. The speed of the elevator was designed for minimum lifting time, and travels at approximately 200 ft per minute.

The large slide valves and expansion joints in the main structure are provided with trolley beams with permanently attached trolleys and electric hoists with adequate lifting capacity and cable length to pick up these units and move them outward for lowering to the ground level and released upon the flat bed of a truck. All of the slide and relief valves are fitted with handling lugs so that slings and improvised bridles are not necessary for handling. The main relief valves on the reactor are picked up, when removing, with an overhead trolley for lowering to the first platform below. A second hoist on platform trolleys pick them up to be placed inside the elevator cage to be brought to the ground level.

The building that houses the electric motor driven turbo-compressors is equipped with a 10-ton box crane which is manually operated by an employee from the floor level. It has sufficient lifting capacity to raise and move any one of the major component parts of either turbo-compressor. This crane was installed immediately after the building frame was erected so that it could be used for assembling the heavy machinery without bringing outside cranes into the area.

Most of the pumps in the unit are installed outside any building, but several requiring low temperature weather protection are located in a pump house. The building is designed with a maximum width roll door at each end so that any unit can be readily removed from the building. The aisle in the pump house has adequate width and clearance that large equipment can be skidded into and out of the building. All of the pumps installed outside are placed in certain relationship with overhead piping that they can be reached readily from the adjacent roadway with motor cranes.

All of the gas plant columns and the main fractionator tower are equipped with overhead trolley structures for the removal of safety valves and inside equipment. All of the trolleys and the manholes in the towers have been engineered and placed so a truck can be spotted directly beneath to receive any equipment or material removed from the column.

The building that houses the four, 600 hp Ingersoll-Rand two-stage compressors is built of steel and transite, transite being employed for roof and siding. The foundation block to support the engines is extended upward from grade to the floor level, which is approximately 6 ft from the top of the ground so as to provide a grade setting for manifolds, suction and discharge lines at grade for greater efficiency of servicing. The area beneath the floor at the points where lines and piping are connected to the engines and compressor is open to provide natural ventilation and remove hazards of gas pockets. Ample ventilation of the building is provided with four wide vertical roll doors in the east wall which remain open except during inclement weather. Full building length trolley beams above the power cylinders and over the compressor cylinders with adequate transfer trolley beams provide a maximum of service so that it is not necessary to move any part from one engine across another to have access to a transfer trolley beam. Another transfer trolley, or switching arrangement, provides means of moving any part of any machine from its operating position to one of the large roll door opening in the east side so that it may be easily loaded on a truck.

To provide adequate service when repairing refinery equipment, a new shop building 140 ft wide and 340 ft long is included in the Lima expansion program. It is built of structural steel and has corrugated transite side walls, and built with a high and low bay running the full length of the building. The high section is equipped with a 15-ton bridge crane covering the entire area, and is supplemented with several one-ton jib cranes, each having a swing radius of 25 ft. A depressed railroad spur is placed in the high bay section so that indoor loading and unloading can be accomplished with the 15-ton bridge crane. The interior walls and the ceiling of the shop are covered with a blanket of glass wool, three inches in thickness, which is supported on expanded metal lath attached to the purline of the roof structure. This method of covering the walls and ceiling provide both insulation and soundproofing and adds materially to the appearance of the shop. The design of the building permits assembling all of the maintenance craft under one roof and affords maximum flexibility in equipment use and labor allocation. Adequate, scientifically designed lighting is installed so that operators of machines and equipment can work efficiently at any time, day or night and in any type of weather conditions.

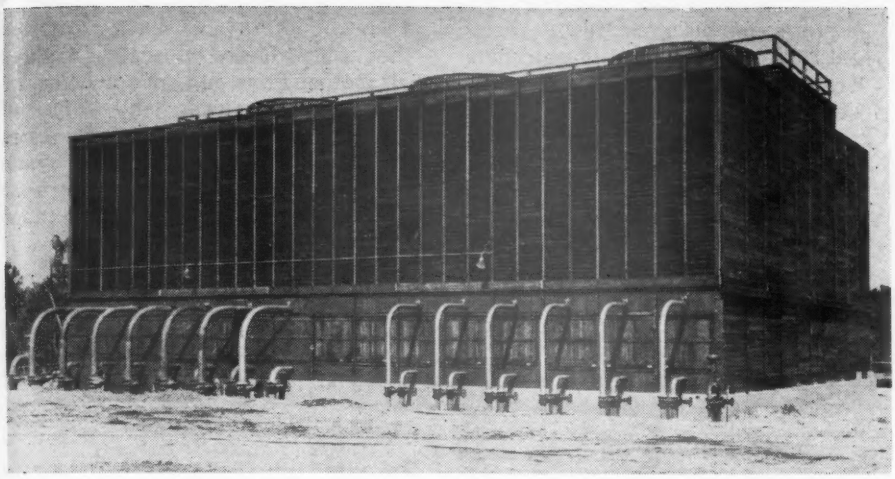
The modernization and expansion program set out by Sohio at Lima has resulted in radical changes in the quantity and type of products. This is shown below in the "Before and After" tabulation.

Lima's Operation Before and After Catalytic Cracker and Crude Coker Installation.

Tabulation, continued:

	Before		After	
	Bbl per day	Volume per cent	Bbl. per day	Volume per cent
Crude	18,200	100.0%	27,000	100.0%
Excess B-B	0	0.0	880	3.3
Naph. specials	300	1.6	0	0.0
Gasoline	7,200	39.6	17,500	64.8
Kerosine	900	4.9	1,190	4.4
No. 2 F.O. & diesel	3,500	19.2	4,380	16.3
Tractor fuel	100	0.6	100	0.4
	(½ kero-½ nap)			
4A fuel	700	3.8	0	0.0
Heavy fuel	4,300	23.6	300	1.1
Coke (10#/gal)	300	1.6	1,320	4.9
Cat coke (10#/gal)	.....	.....	720	2.7
Gas & loss	1,300	7.1	2,140	7.9
	18,600	102.0	28,530	105.8

A break-down of this tabulation shows that one of the troubles that has pursued the average refiner recently has been all but eliminated. Instead of, as before when 19.2 per cent of the charge resulted in bottoms for which there is no market, there is only 1.1 per cent of the charge recovered in this bracket. Gasoline yield is increased from 39.6 to 64.8 while gas and loss has been increased only 3/10 of 1 per cent. ★ ★ ★



Three-cell double-flow water-cooling tower with coil shed that contains atmospheric cooling sections.

WATER-COOLING TOWERS

HOWARD E. DEGLER†

PART 3 — OPERATION AND MAINTENANCE*

PAGES of recommendations could be written on the starting up, operation, maintenance, and shutting down of water-cooling equipment in order to obtain maximum results under varying load requirements and changing weather conditions. The more important features of inspection, cleaning, operation, and maintenance of water-cooling towers will be discussed in the hope that better performance may result.

Water Treatment

The water treatment problem as it applies to water-cooling towers can be divided into three parts: The prevention of scale formation on heat-exchanger equipment, the prevention and control of algae, and the control of delignification of cooling tower lumber. However, injurious delignification of wood is seldom encountered in cooling tower operation.

The amount of make-up water required by a cooling tower depends upon evaporation loss, drift loss, and blow-down. Evaporation losses average 0.75 per cent of the water circulated for each 10 F range. Drift loss is the water carried from the tower by the air current in the form of droplets or mist. This loss approximates one-tenth of one per cent in properly designed induced draft towers; most cooling tower manufacturers will guarantee a drift loss not to exceed two-tenths of one per cent. The amount of blow-down water required depends upon the hardness of the circulating water, the type of water softener or inhibitor used, and the amount of drift loss. Blow-down is normally controlled to maintain the concentration of dissolved and scale-forming solids below the point where the formation of scale would occur or would be caused by corrosion.

Scale. Some scale-forming materials are found in practically all water, however, the most troublesome in water-cooling systems are normally calcium and magnesium carbonates. Too high a concentration of dissolved solids in cooling tower water will raise the effective wet-bulb temperature, which in turn raises the temperature of the water leaving the tower and may cause sludge or corrosion in the system. These dissolved solids also cause scale formation on equipment thereby causing a reduction in the heat transfer rates.

Scale can be reduced materially or prevented by treating the make-up water by some softening process. The following methods for scale prevention may be used, however, the choice is largely one of an economic nature and since water treatment requires close regulation and control, a competent chemist should be consulted.

1. Use the lime softening process.
2. Use hydrogen-replacing Zeolites that do not produce sodium bicarbonate or carbonate.
3. Use conventional Zeolite softening and add sufficient sulfuric acid thereby converting the bi-carbonates to sulfates.
4. Use one of the soluble phosphates or convert the carbonates to sulfates by adding sulfuric acid.
5. Use of sodium chromate.
6. Regardless of the water-treatment method used, a systematic program of blow-down should be established to control the dissolved solids in the circulating water.

Algae. Algae formations may plug nozzles and prevent proper distribution of the water over the tower filling. This growth may also collect on the equipment served by the cooling tower and thereby decrease the heat transfer rate. In addition to algae, a microscopic examination of slime that may accumulate on the water side of various heat transfer surfaces shows inorganic matter bound by filamentous forms of bacterial growth. Destruction of this slime by chemical additives to the water eliminates the binder for this inorganic matter and thus precludes the possible future formation (growth) of algae.

Liquid chlorine is a frequently used algaecide; it is an effective and inexpensive means of controlling this troublesome growth. Regardless of the algaecide used the growth, in time, may become immune to that chemical and the treatment must be changed. This new treatment is continued until the old treatment again becomes effective. Other chemicals that can be used effectively to control algae are: Copper sulfate, liquid bromine, copper chloride, potassium permanganate, chlorinated lime, and various blends of chlorophenates.

It would be expedient to begin the use of an algaecide before too much algae has begun to grow, if not, too

†Technical Director, The Marley Company, Inc.

*Part 1, "Principles and Applications," appeared in a previous issue; and Part 2, "Types and Construction" appeared in the November issue of *The Petroleum Engineer.*

EXCLUSIVE

much of the growth would be killed at one time, and the dead algae would tend to clog the system as it is carried off by the circulating water.

Delignification. Delignification is defined as the decomposition or apparent rotting of lumber and is caused by the combining of sodium carbonate, held in the cooling water, with the lignins and part of the cellulose products of the wood. Delignification leaves the wood in long, stringy fibers. Prolonged exposure reduces the structural strength of the wood. The critical points in the tower, with respect to delignification, are the parts that are alternately wet and dry. Here, evaporation greatly increases the concentration of the sodium carbonate. An indication of the extent of sodium carbonate in the circulating water is the pH* of that water. A pH value of 9 to 11 may indicate a high concentration of sodium carbonate; it is desirable to keep the pH value between 7 and 8. In any case, the primary problem is the elimination of the sodium carbonate and not of necessity a question of pH.

The water treatments recommended in the scale prevention section above are set up to keep the pH value and the tendency toward delignification at a minimum. It should be remembered that when sulfuric acid is used to neutralize the sodium carbonate, the pH value should be kept at about 7.5 and never dropped below 7.0 because of the danger of corroding the heat-exchanger equipment, unless inhibitors have been added.

Two-speed Motors

For readily adapting tower performance to temporary or seasonal decreases in heat load, and especially for winter operation, the use of two-speed motors (for fan drives) is recommended. The chief advantage is that when operated at half-speed, fans require only about 15 per cent of the power used at full speed. Particularly in multi-fan towers, the ready flexibility provided by two-speed motors results in considerable savings even though load reductions may sometimes call for only one or a few fans to be operated at half speed.

When fan-speed is reduced to half, the hot and cold water temperatures of a cooling tower will increase 6 to 8 F for a given wet-bulb temperature and heat load. When the wet-bulb temperature is 10 F below design temperature the fan can be operated at half speed and the design water temperatures obtained for a given amount of water. For the same wet-bulb temperature and the same range (but 6 to 8 F higher hot and cold-water temperatures) a tower would require approximately 60 per cent more effective cooling area at half fan-speed than at full-speed operation for a desired heat load.

Another speed consideration is that during the winter months when it is not cold enough to shut down the fans completely, yet cold enough that ice tends to form at full fan speed, the condition may be met readily by operating some or all of the fans at half speed.

Starting Up

Before a water-cooling tower is started up for the first time, or after a long shut down, it should be cleaned and inspected thoroughly. Remove all dirt and trash that has blown, or otherwise collected, in the catch basin beneath the tower. Clean suction screens as well as the nozzles and other parts of the water distribution system located near the top of the tower.

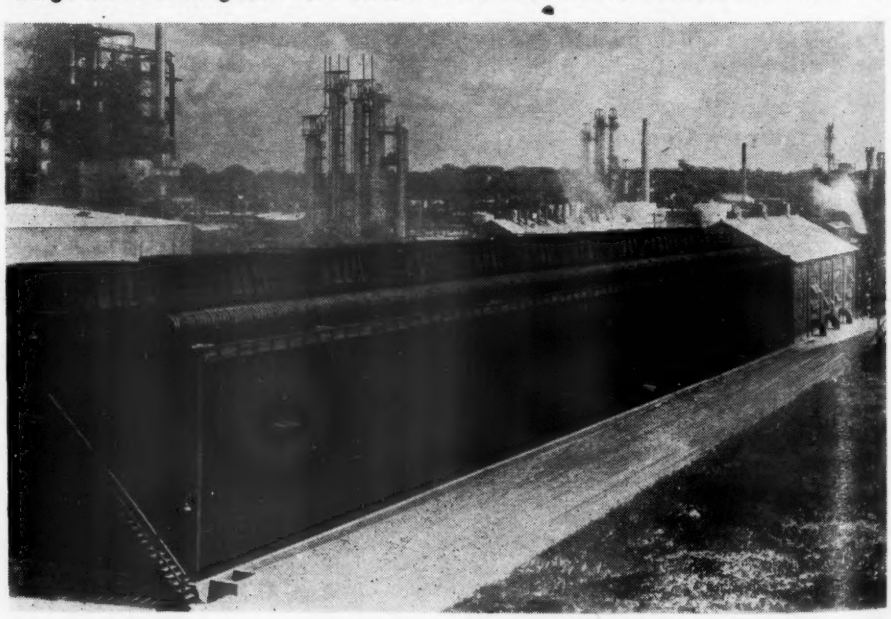
Inspect the fans (if used) and make sure that all bolts are tight, that fans rotate freely, and that ample clearance exists between blade tips and fan cylinder. Check the fan drive-shaft and see that all bolts are in place, that flexible couplings or universal joints are in good condition, and that the shaft guards are in position and properly secured. Motor, drive-shaft, and speed reducer should be aligned. Make sure that speed reducers are filled with proper grade and quantity of clean oil. Also see that the vent connection on top of the speed reducer is open. Inspect motors and make sure that they are properly lubricated. Tighten all motor frame and anchor bolts. Inspect nozzles, piping, and flumes of the water distribution system. Look over the framework of the tower and tighten all loose bolts. On wooden towers, do not tighten bolts too much or the swelling of the wood may break them.

See that the catch basin is free of leaks. Small leaks in wood basins will stop when the wood becomes soaked. In concrete basins pay particular attention to expansion joints in the walls and floor. If a float valve is used for make-up, be certain that it works freely and does not leak when closed. Inspect the overflow to make sure it is open. Check the sump assembly to see that the screen and cover (or suction screens in the case of concrete basins) are properly installed.

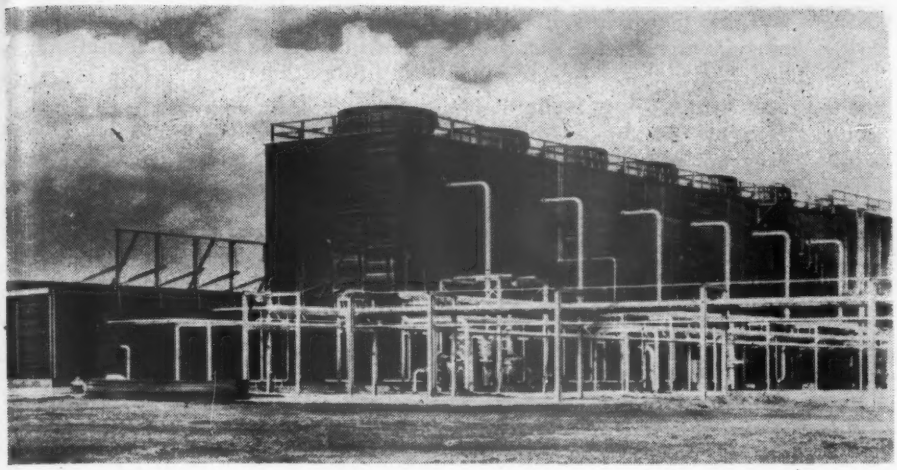
Fans

Large fans are used to draw air through the tower and discharge it upward to the atmosphere. Start the fans and inspect them immediately to make sure that they are running freely. It is very important that fans should rotate in the direction specified by the tower manufacturer. Check the power input to the fan motor. If these motors are not loaded in accordance with the specified horsepower, contact the manufacturer to obtain instructions for setting the fan-blade pitch. Speed reducers are sometimes noisy when started for the first time, but will generally quiet down when properly broken in. Excessive noise developing in speed reducers after they have been

Large water-cooling tower (10 cells) with redwood-staved headers and end inlets.



*The pH value of a solution is defined as the logarithm of the reciprocal of the hydrogen-ion concentration. A solution having a pH value of 7.0 is neutral.



Multi-cell tower with individual water inlets and extended coil shed (left end) that contains atmospheric cooling sections.

in operation for some time indicates considerable wear and probable need for repair.

Circulating Water System

The float valve should be adjusted to maintain a water level in the catch basin of 5 to 6 in. below the wood filling. Maintain at least 6 in. of water in redwood or steel basins. Place all valves in open or closed position as required, and prime and start the circulating water pumps. Check the amount of water being circulated and adjust to approximately the quantity for which the tower was designed. Water flow can be checked by means of an orifice meter, weir, pitot tube, or pump performance curves. Equalize water distribution so that all parts of the tower are receiving like amounts of water.

Operation

To obtain the best operating results the distribution system and the catch basin under the tower must be kept free of dirt, algae, and scale. Fans driven by variable speed devices must not be operated above the speed for which they were designed. Concrete basins should be provided with double suction screens, that is, one set of screens placed in front of another and so positioned that all of the water goes through both. When cleaning screens, remove, clean and replace the screen through which the water first passes before removing the second screen for cleaning. Check oil level in speed reducer weekly and add oil when necessary to maintain proper level. Drive shafts equipped with splines, gears, or universal joints should be greased weekly. Drive-shafts equipped with couplings using rubber-bending members do not require lubrication.

A regular daily inspection schedule is recommended to determine whether the cooling tower is operating properly. The cooling tower in operation becomes but part of a system made up of several other auxiliaries. Therefore it may be blamed for unsatisfactory performance, which is only a symptom of failure in another part of the system.

Reduced cooling range indicates a light heat load or excess water quantity. Increased cooling range indicates heavy heat load or insufficient water quantity. When a condenser becomes badly scaled, water quantity circulated is frequently retarded and pumping head increased. Higher cooling water temperatures usually indicate this condition. Thus, if water quantity is incorrect, (1) check pump for speed, pressure, and freedom from air, (2) check condenser for scale, air, or restrictions, and (3) check pipe lines for air, partially closed valves, dirt, or restrictions.

A daily general inspection should be sufficient for most cooling equipment installations. The accompanying inspection and maintenance schedule should be used by the operator to obtain continuously good performance and least cooling tower maintenance.

Cold-weather Operation

Extremely cold water normally does not increase performance to any great extent, but operating hazards are increased considerably. Water-cooling towers operated in sub-freezing weather are subject to ice formation on the louvers and the outer portion of the filling. To prevent icing in cold-weather operation, the cold raw water (tower circulating water) temperature should be maintained as high as practical, taking into consideration the effect upon the economy of the equipment served. One or more of the following procedures are recommended for induced draft towers: (a) Run two-speed motors on half speed; ice formation may be retarded and fans will require only about 15 per cent of the power used at full speed; (b) shut down fans completely, this may retard ice formation; (c) cover upper portion of louvered area; (d) reduce water flow to the tower and shut off some of the cells; (e) bypass the cooling tower with part of the water and shut off some of the fans or cells of the tower.

If ice should form on the louvers and filling, one of the following methods of removal could be used: (a)

MAINTENANCE INSPECTION SCHEDULE
General Recommendations
(more frequent inspection may be desirable)

	Fan	Motor	Drive Shaft	Speed Reducer	Eliminator	Filling	Cold Water Basin	Distribution System	Float Valve	Structural Members	Suction Screen	Steel Casing
Check for unusual noise or vibration	W	W	W	W						Y		
Inspect keys and keyways		S	S	S								
Check oil level, and oil for water & dirt				M								
Make certain that vents are open				M								
Inspect for deterioration			S		Y	Y			Y			Y
Lubricate		S	M	S								
Tighten loose bolts	Y	Y	Y	Y						Y		R
Repaint	R	R	R	R			R			R		Y
Clean						R	R	R			R	
Inspect for clogging							W	M			W	
Check for leakage							M		M			
Change oil, at least				S								
Check oil seals at speed-reducer shafts				S								

W-weekly; M-monthly; S-semi-yearly; Y-yearly; R-as required.

Reversing (for limited time) the rotation of the motor driving the fan and thus blowing the warm air backwards and out through the louvers; (b) cover upper portion of louvered area.

Mechanical Maintenance

A regular schedule should be set up for the mechanical maintenance of water-cooling equipment. Well-maintained equipment provides the best operating results and the least over-all maintenance cost. Ball bearing motors should be greased with an approved water-resistant grease every one to three months. Follow instructions issued by the motor manufacturer when greasing motors. Do not overgrease ball bearings as overgreasing will cause their failure almost as quickly as undergreasing. Insulation value of the motor should be checked yearly.

Drain out the old oil and refill speed reducers with clean oil of the proper grade every 3000 hours operation, or at least twice a year. The proper grade of oil for the speed reducers is usually shown on the nameplate. Excessive clearance or play between pinion and ring gears indicates wear. End play of the pinion shaft or side play of the fan shaft shows bearing wear. Oil leaking around the pinion shaft or fan indicates that the oil seals are worn and should be replaced.

Paint fan blades and hubs as often as necessary to prevent corrosion. Corrosion difficulties vary considerably, depending on the nature of the water used in the tower and the atmosphere at the point of installation. Tighten all blade clamps and hub bolts, and rebalance when necessary.

Structural Maintenance

Remove all dirt, scale, bugs, and debris from the distribution system. Replace or repair all damaged or missing parts. Clean and paint all corrodible metals as required. Redwood does not require protection from the weather, but in some cases it may be desirable to paint it for appearance. Tighten all loose bolts, making allowance for the swelling of the wood when wet.

Drift eliminators should be cleaned when appreciably dirty. Dirty eliminators reduce air flow through the cooling tower. Eliminator spacers should be aligned. When installing eliminators do not leave holes between eliminator bundles, or between ends of bundles and adjacent members, as these spaces would allow excessive drift. When wood filling slats become dirty they should be cleaned. Replace broken or badly warped slats, maintaining the same "pattern" or spacing of slats both vertically and horizontally as in the original installation.

Shutting Down

When a cooling tower is to be shut down for an appreciable time, particularly in cold weather, it should be drained to prevent damage from freezing and corrosion. Leave the drain open to allow rain and melted snow to escape. Operate the fans for a period of approximately five minutes once a week to keep the upper fan shaft bearing oiled. Protect metal parts from corrosion.

Maintenance or repair work should be done while the cooling tower is completely shut down if possible. This gives the best opportunity for inspection and maintenance and does not restrict the operation of any of the equipment served. A properly maintained and efficient water-cooling tower is one of the most important factors in a modern plant requiring cooling water and will greatly improve the overall efficiency of the process involved.

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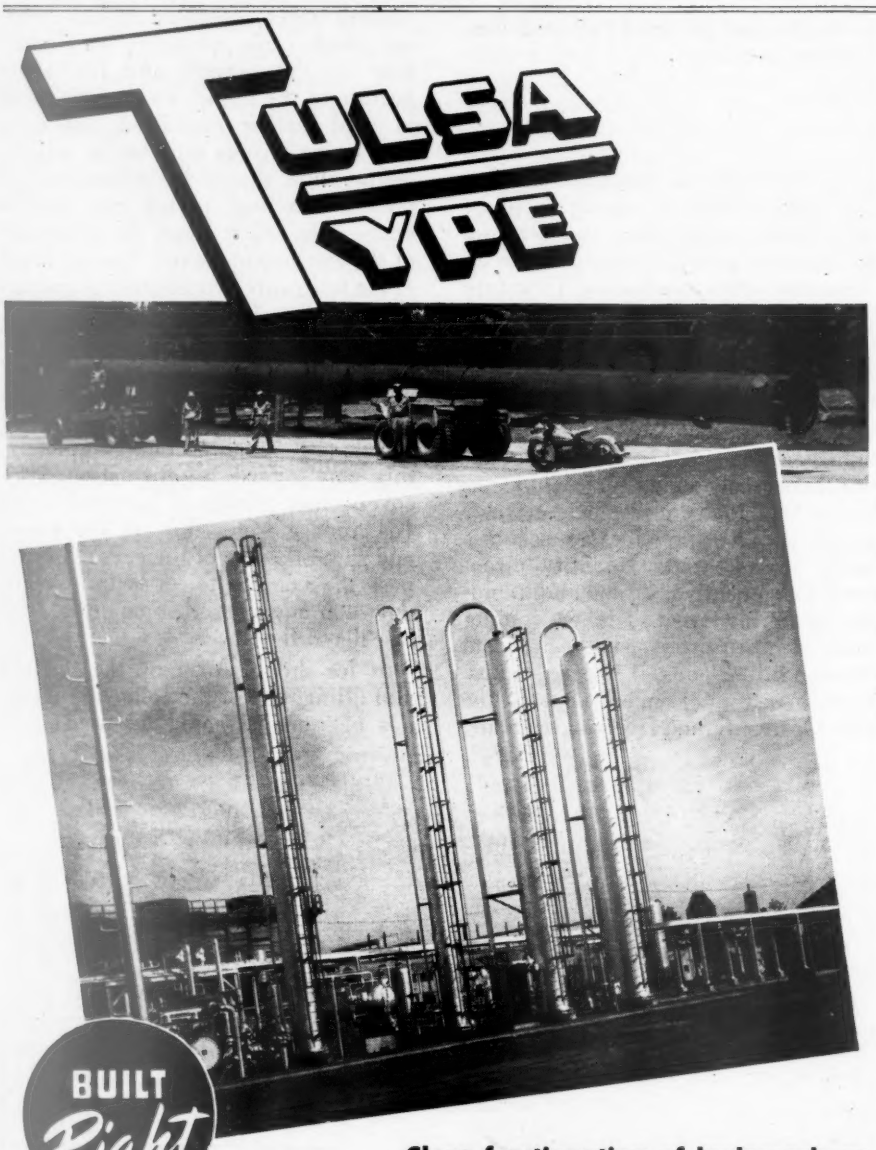

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PART 3—THE CHECK ESTIMATE

How to Estimate Plant Construction Costs

GEORGE E. BROOKS

In previous articles of this series the fundamentals of estimating were enumerated and the preliminary type of estimate was discussed in some detail. The next step or refinement in estimating is the type of estimate which has been referred to as the check estimate for want of a better name.

When informal approval of the project as a whole has been granted on the basis of the preliminary estimate, a more detailed breakdown of the cost is desirable upon which to base a formal request for an appropriation to complete the project. It not only is desirable from the standpoint of having an itemized list of anticipated expenditures, but it also affords the estimator an opportunity to delve a little further into the cost figures he has been using and possibly discover that errors in correlation or judgment have been made. During the preparation of this check estimate any indication that the total appropriation is going to be materially effected can be brought to the attention of the proper parties, and if the total amount of money already accepted as the total cost of the project is to be held firm, then changes in design or specifications can be undertaken to see that costs are held in line.

In Article 1 mention was made of the fact that for estimates of cost to have any future value they should follow some system or form. The form chosen for any particular field of estimating should be of sufficient flexibility that it will lend itself to easy adaptation from job to job over the complete range of projects with which the estimator is associated. The scope of the form to be used will depend on the judgment of each individual estimator. As an illustration of a system that has proved satisfactory in the petroleum industry, the outline in the above box is given.

Direct Costs

Foundations	Cooler Boxes and Coils	Fireproofing
Piles	Towers and Vessels	Painting
Earthwork	Trays and Packing	Scaffolding
Buildings	Horizontal Drums	Mech. Handling Equipment
Heaters	Atmos. Stor. Tanks	Waste Disposal
Boilers	Pumps and Drivers	Piping
Stacks	Compressors and Blowers and Drivers	Testing
Flues	Refrigeration Equipment	Roads and Bridges
Structural Steel	Special Equipment	Railroad Spurs
Structural Timber	Instruments	Loading Racks
Elevated Concrete Structures	Communication Equipment	Docks
Cooling Towers	Electric Lights	Field Tankage
Water Supply	Electric Power	Freight and Trucking
Heat Transfer Equipment	Insulation	Miscellaneous

Indirect Costs

FIELD CONSTRUCTION EXPENSES

Field Office Clerks, Timekeepers, Typists, etc.	Construction Supplies
Temporary Construction Buildings, Roads, Utilities, R.R. Spurs, etc.	Inspect and Expedite
Material and Tool Handling	Taxes and Insurance
Home Office Constr. Dept.	SERVICES
Erect Derrick and Dismantle	Engineering and Drafting
Cleanup	Construction Equipment Rentals
Standby Operators	Field Supervision
	Overhead and Profit

The outline given above is essentially what was meant in Article 1 of this series when it was advised that a good system for keeping track of the trend of expenditures on a project was to give the field personnel a cost outline. With the list of items shown and an estimated amount opposite each an excellent guide is available for the field representative to use in detecting a possible overexpenditure.

Digressing for a moment from the check estimate, a few words on cost recording may be apropos at this point. If a tabulating machine is available either within the organization or for rent, the fund of data that can be accumulated from the above outline is almost unlimited. For instance, let us take the first item, Foundations. By assigning a code number such as 01 to the general heading and then listing the various subdivisions under that heading, each with a subcode number, thusly:

01 FOUNDATIONS
- —1 Equipment
- —2 Structures
- —3 Tanks
- —4 Floors
- —5 Paving
- —6 Catch Basins
- —7 Trenches
- —8 Unit Drainage,

the accumulated cost to date of any type of foundation can be determined easily and quickly by setting up the tabulating machine to record all information appearing on cards punched with the particular code number. All orders, labor charges, contracts, etc., pertaining to the item coded are marked with the appropriate code number upon receipt and the amounts represented by these invoices are punched on the proper cards in the usual manner. At the end of the job these cards are saved for future reference, or the complete breakdown of costs on the job can be run off and distributed to the estimators. By proper coding, material and labor charges can be separately recorded and contract charges can also be distinguished from direct charges. If access to a tabulating machine is not readily attainable and cost records must be kept by hand entry, the system can still be used but not with the degree

EXCLUSIVE

of refinement described above or ease of compilation of data. The breakdown into subheadings under each main heading would doubtless not be judged worth the cost in time and personnel. A separation of some sort between labor and material, however, will prove worthwhile.

Getting back to the check estimate, let us examine each of the items listed above as making up the total cost of the processing unit being investigated. The first item is foundations. The quantities involved can be estimated from an examination of the flow diagram and a few rough calculations based on soil conditions, wind pressure, and estimated weights of the various pieces of equipment. As an example, the number of cubic yards of concrete in an average steam duplex pump foundation is close to 1/800 times the weight of the pump. If the pump weight is not known, it may be deduced by allowing 80c to $1 per pound when the cost is known. If at this point neither weight nor price is known, the approximate number of square feet it will occupy can be estimated from its known size. By allowing 3 to 3½ ft for depth the quantity of concrete can thus be calculated. For special pumps such as engine-driven pumps where a large flywheel is involved more care should be taken in sizing the foundation. The mass of concrete in this case may be necessary for vibration control more than merely to support the equipment. Similar rules of thumb are available for other types of equipment but more accurate results will be obtained if the estimator will develop curves of the type shown in Fig. 10. This set of curves was developed for estimating quickly the weight of plain vessels without connections or manways. The total outside area of the vessel is obtained by reading the left hand scale opposite the point where the length from bend line to bend line between elliptical heads meets the curve corresponding to the diameter. Allowing about 10.2 lb per square foot for each square foot of area per quarter inch of thickness the weight of the plain vessel can be quickly calculated. Later the knowledge of the area of the vessel will come in handy when figuring insulation. By counting the nozzles and manways, additions can be made for these items from similar tables. With the weight now known the size of the foundation can be determined by allowing percentages for wind and live load, which the estimator has developed.

When tabulating foundations it will be helpful to segregate them into four classes as follows:

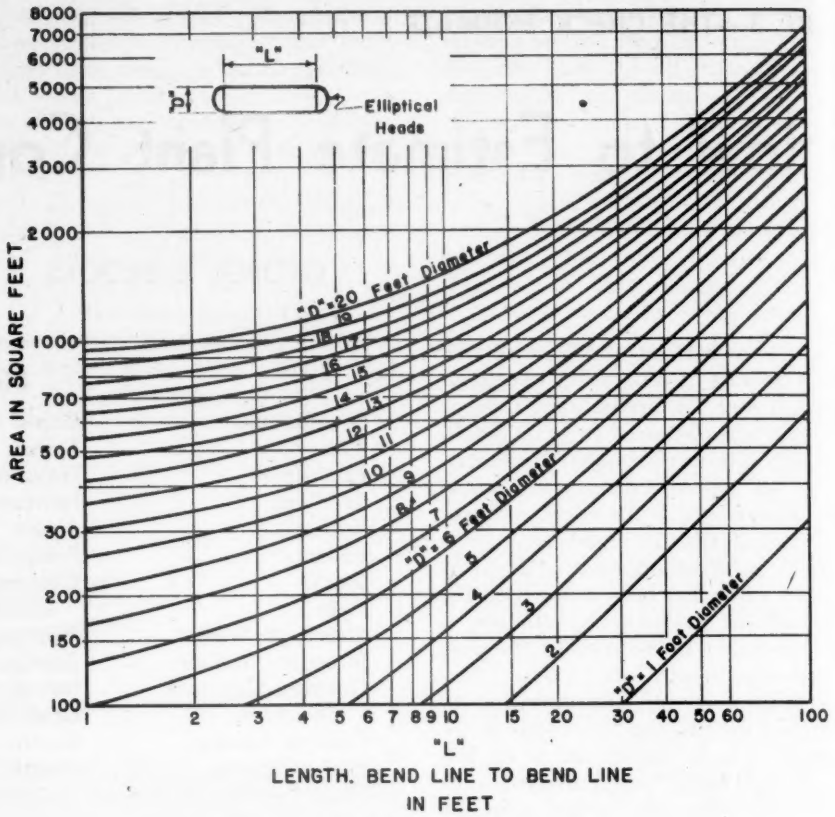


FIG. 10. Surface area of vessels.

Class 1 Heavy Foundations
Fractionating towers, Chimneys, Upshot Heaters, Exchanger Supporting Structures, etc.

Class 2 Medium Foundations
Pumps and Compressors, Buildings, Box Type Heaters, Tank Rings, etc.

Class 3 Light Foundations
Pipe Supports, Trenches, Drains, Catch Basins, Firewalls etc.

Class 4 Miscellaneous Foundations
Paving, Curbs, Floors, etc.

The reason for suggesting the above breakdown between types of foundations is that costs for concrete work in each class will be found to run fairly uniform within the group while there will be considerable variation between groups. Some types require more formwork than others and labor will run higher in proportion to material although in other instances where large masses of concrete are poured in one operation formwork may be relatively simple.

Some typical unit costs for each of the above classifications are enumerated below:

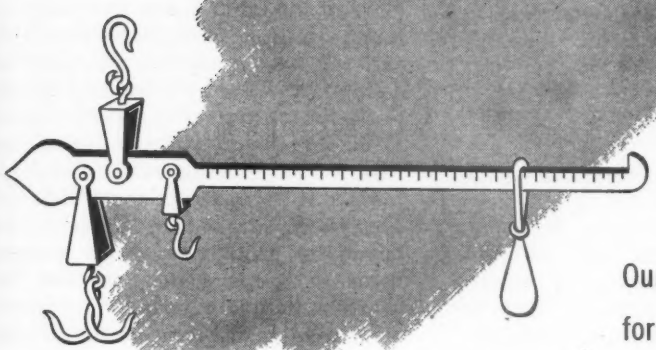
Class	Unit	Material	Labor
1	cubic yard	$20-$25	$25-$30
2	cubic yard	$20-$25	$40-$45
3	cubic yard	$25-$30	$65-$70
4	cubic yard	$15-$20	$30-$35

These costs include all charges attributable to foundations such as excavation, formwork, pumping, stripping forms, backfill, placing reinforcing, anchor bolts, etc., but do not include any indirect charges such as overhead and general contracting costs.

If the total quantity of concrete in all foundations has been determined by ratio from some other similar job then a reasonably accurate cost can be found by using an average cost for all classes of $21 for material and $35 for labor. When the check estimate is completed, still another check on the accuracy of the estimate of this portion of the job can be had by comparing the percentage relationship of foundations on this job to the total direct costs with the same ratio on other completed jobs. For oil refinery units this percentage runs between 3 and 6 per cent.

The next item in the list is piles. It is closely associated with the preceding item of foundations but has been listed separately as it is common practice to have a contractor who specializes in driving piles come onto the job and perform this phase of the work under a separate contract. From the weight of the equipment and the weight of the foundations the number of piles can be determined from the allowable bearing capacity of the

How "heavy" is resourcefulness?



Ours would weigh nearly four billion pounds, for that's how much Attapulgus Fullers Earth and Porocel Activated Bauxite we've shipped to petroleum refiners.

When weighing resourcefulness—as it applies to percolation adsorbents and solid catalysts—two factors are particularly meaningful: First, the desire of all the people in the company family to tackle problems that require particular skill and broad technical knowledge. Second, the company's physical reach—mines, plant equipment, specialized laboratory and engineering facilities—for good men can do no more than their tools permit.

These resources abound at Attapulgus and Porocel. They dovetail to put a firm base under a completely integrated service. And—for world-wide petroleum refining—to put the right adsorbents to work under the right conditions.
May we be of service to you?

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Dept. Y, 210 West Washington Square, Philadelphia 5, Pa.

Parts 1 and 2 of this three-part series presented the fundamentals of cost sstimation and the methods for arriving at the details and total of the Preliminary Estmiate. This third and concluding installment, The Check Estimate, expands the presentation of methods for arriving at more exact and dependable detailed estimates of costs; maintenance and use of cost records; data on individual cost items and their estimation when exact figures are unavailable; use of curves and graphs on various size, area and other important physical data items. Especially useful are complete check estimate data sheets with sample calculations showing how each cost item is arrived at.

Reprints are in the process of being made and requests for them will be answered as soon as they are available.

piles. The length of the piles will be directly proportional to the bearing capacity desired and the characteristics of the soil involved. A unit cost of $.50 to $.70 per foot for wooden piles in place and $2.50 per foot for concerte piles will be accurate enough for estimating piling costs where a large number of piles are to be driven. If only a few are involved and they are not situated in a small area, the cost of bringing in the rig and relocating a few times may cost more than the actual driving of the piles. The unit costs quoted above are average for 100 or more piles and include all charges usually applied by pile driving concerns. The estimated cost of this item can be used later to check bids for the awarding of the pile driving contract. The cost of this work is usually entered under the material column in the cost estimate as it will not have any charges added to its labor portion such as taxes, insurance, etc. when figuring the indirect costs. They have already been included. By showing this cost in the material column the piling becomes just like any other item of material that the general contractor purchases for use on the job.

Earthwork is usually estimated by the cubic yard and costs vary from $.20 per yard for machine work to $2.50 per yard for some hand excavation. The quantities of each type of work are up to the judgement of the estimator based on previous experience in the field and whatever knowledge he has of the job site conditions.

Buildings in the check estimate mean everything above the foundation and floor which have been included in the first items of foundations. If preliminary drawings are available, the major quantities of building materials can be quickly taken off and priced by phone calls or records. If only the general dimensions of the buildings are known, the total cost can be determined on the basis of total cubic feet of volume or square feet of floor space. These unit costs will vary from $.65 per cubic foot for steel frame and corrugated asbestos roof and sides to $.95 per cubic foot for steel frame and brick walls depending on the climate and local building specifications as to number of toilets, etc. Heavy reinforced concrete construction with equipment loads on the roof may run as high as $1.65 per cubic foot. The actual cost of some existing similar buildings may also be used to estimate buildings by taking advantage of the ENR Index to bring the cost up to date. When entering the cost in the estimate when only the total cost has been determined it should be split roughly 48 per cent to material and 52 per cent to labor. All nominal heating and lighting, partitions, toilets, etc. are included in the unit costs given and nothing more need be added unless there are items of special nature not ordinarily found in buildings of the type under discussion.

Fired heaters present a more complicated problem than any of the items discussed up to this point. Arbitrary rules for predicting their costs are not easily set forth. It should be possible, from the flow diagram, to settle the number and size of tubes required, the type of materials from which they must be made such as carbon steel, Chromium-Moly., or other alloy and to determine the type and class of fittings that are called for by the temperature and pressure conditions. With this information as a guide the cost can be most easily ratioed from the known cost of a similar type heater of comparable size using an exponent of 0.7 in adjusting for size and the ENR index for adjusting for cost increase since the known heater was built. Heat liberation or absorption duty is another good basis for ratioing heater costs, when throughput is not felt to be reliable as a ratio basis. If the new heater is to embody alloy materials where the old heater used plain steel, then the cost of tubes and fittings in the base heater should be segregated and its percentage of the total cost of the heater determined. Using this percentage the cost of steel tubes and fittings in the new heater can be determined and then adjusted for the added cost of using alloy material for this portion of the heater. The remainder of the heater will not ordinarily be affected by the use of alloy in the tubes unless the temperature is the governing factor in which case slightly thicker walls may be called for. A rough free hand sketch of the heater in question will be found to be very helpful in visualizing just what items are being included and adjusted. If it is felt a more detailed breakdown is called for, it can be obtained by proportioning the various items of material that go into the heater individually from known quantities used in the base heater. Items other than tubes and fittings can be used on square feet of wall or floor surface. The structural steel needed will be greatly effected by the number and size of operating platforms and tube pulling structures necessary.

The estimating of boilers is a function of the pressure required and whether or not elaborate water treating is required as well as a function of the pounds of water evaporated. Superheating is another item that should not be overlooked. Normally, for 200-lb steam generation without water treating, $3 per pound of steam generation will approximate the cost of a boiler installed including the firing aisle building. If water treating is required, which more than likely it is, then a cost of $5 per pound will probably be nearer correct. This item is similar to piles in that many times a contractor specializing in furnishing and erecting boilers is employed to handle this phase of the project up to and including test and acceptance of the finished boiler. If that is to be the case, then the cost of the boiler should be shown on the material side in the cost estimate for the same reasons advanced for including piles in that column. If costs of existing boilers are available the new boiler can be estimated from these data in a manner similar to that described for fired heaters. Care should be taken, however, to be sure that the design of the base boiler has not been outmoded.

Stacks and chimneys are another special item similar to piles in that several companies are available who concentrate their efforts in that field. With the diameter and height determined from data obtained from the

flow diagram the volume of brickwork or concrete can be calculated and the cost ratioed from the cost of existing chimneys. In some localities a phone call to the local representative of a chimney builder will result in a quotation on an estimate basis to be confirmed later when all data has been accumulated and settled upon.

Flues and ductwork of steel are best estimated on a weight basis. From the flow diagram the quantities of air or gas to be handled can be calculated and from standard tables the cross sectional area required can be determined. Using 10 to 15 lb per square foot of outside area of ductwork the total weight of ductwork can be readily computed. The ducts will probably cost in the neighborhood of $.20 to $.30 per pound for fabrication and from $.10 to $.20 per pound for erection. Any outside structural support required should be figured separately and added in unless included under the general heading of structural steel.

Structural steel is best estimated by roughly laying out the necessary structures such as equipment supports, platforms, ladders, stairs, and pipe supports. The major columns and beams should be chosen with adequate allowance for unforeseen loads and stresses. The weights of these members can be taken from any steel handbook, some of which have excellent tables of allowable loads and economical sections. For roughly computing weights of structural steel the following average figures may prove useful:

Main structurals 2.2 lb per cubic foot of structure.

Stairs and treads 200 lb per foot of rise.

Walkways 32 lb per square foot.

Ladders 18 lb per lineal foot.

Handrails 11 lb per lineal foot.

Bracing ordinarily runs about 15 per cent of the main steel. The cost of pipe supports will run in the neighborhood of 10 per cent of the cost of the piping. Structural steel at the present time varies between $250 and $350 per ton fabricated according to the complexity of the structure. Erection will cost from $60 to $120 per ton.

Structural timber can be estimated in a similar manner to that described for steel using a unit cost of $100 per thousand board feet (MBF) for material and $80 to $100 per MBF for labor.

Elevated concrete structures consist of upper floors or platforms, slabs above ground level, and any other reinforced concrete structure not classified as a building above the foundation. The approximate sizes of beams, columns, and girders should be determined from a concrete handbook and the quantities of concrete required calculated. Costs for this type of concrete work will be found to run considerably higher than for foundations. Material may run from $25 to $40 per cubic yard and labor from $35 to $100 per yard because of the complexity of beam and girder work and the necessity for supporting elevated slabs with scaffolding.

Cooling towers are usually estimated according to their capacity in gallons per minute, assuming standard inlet and outlet water temperatures. A reasonable figure to use for an induced draft tower of modern design is $30 to $40 per gpm erected. This figure includes a pumphouse, pumps, manifold piping, fans, and other accessories for the tower proper. Water lines to distribute the water and return it to the tower will run between $20 and $30 per gallon of water carried. These unit costs include both material and labor, and will vary according to the distance from the tower to the point of usage.

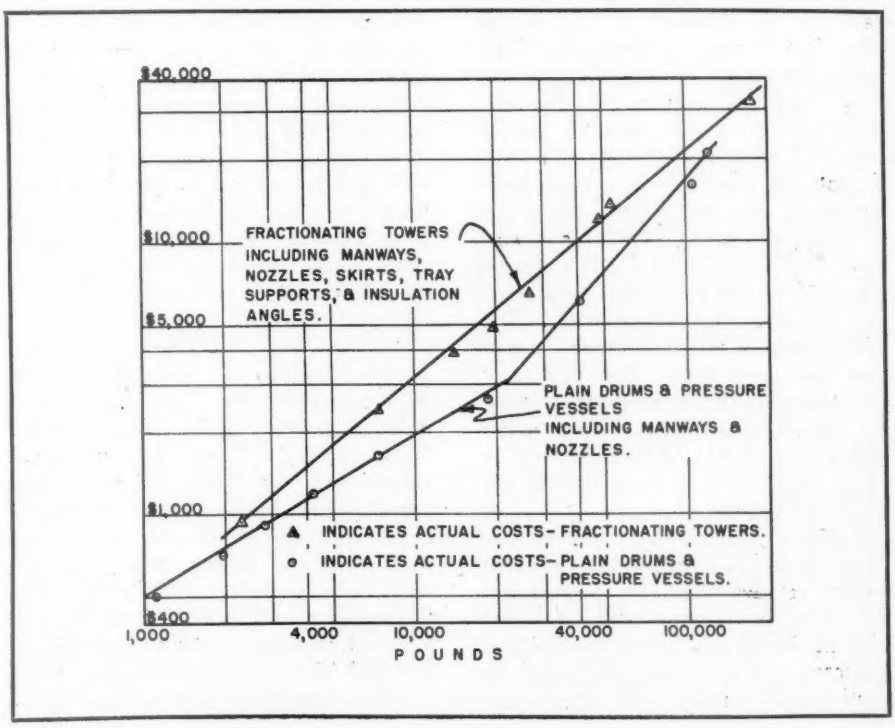
Water supply is becoming of greater importance as present plants expand and new ones are built. Cost of supplying water will depend on whether wells, canals, reservoirs, rivers, or city water is to be the source. Each of these possibilities must be investigated separately and estimated according to its component parts, such as earthwork, piping, drilling, etc. To the total an allowance for chlorination facilities should be added based on known requirements for the type of water available.

Shell and tube equipment can be estimated on the basis of total square feet of surface required. A figure of $3.50 to $4.40 per square foot will cover most cases up to 150 pounds per square inch pressure. If desired, a set of curves similar to those shown for vessels can be developed so that each individual exchanger may be estimated separately. For a given pressure and temperature range and all steel or alloy this curve becomes a straight line when plotted on logarithmic paper. Erection of this equipment averages 10 per cent to 15 per cent of the cost of the material depending on the size of the bundle and its relative location on the unit with respect to the ground.

Cooler boxes and coils are most easily estimated by taking the box as steel work at $.10 to $.20 per pound for material and $.14 to $.17 per pound for erection. The coils should be estimated as manifold pipework at usual pipe prices and allowing $50 per ton for erection.

Vertical towers and vessels can be estimated according to weight. A series of curves for quickly approximating these weights has already been discussed under foundations. Fig. 11 illustrates the type of curve that results when costs are plotted against total weight for pressure vessels. A note at this point should be made of the temperature under which the tower op-

FIG. 11. Cost of towers and vessels according to weight.



ESTIMATE OF COST

EST. NO. _____ SHEET NO. 1 of 4
ENG'R'S. EST. _____

LIGHT OIL TREATING UNIT
12,000 BPOD
CHECK ESTIMATE SUMMARY

PLANT NAME Plant "M"
DWG. NO'S. _____ COMPUTED BY GEB DATE Oct. 20, 1949

ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
Foundations			6800			9800	
Pump House			9050			8450	
Structural Steel			4900			8000	
Shell & Tube Equipment			9500			500	
Vessels			25000			2500	
Pumps & Drivers			8100			1500	
Instruments			20000			7000	
Elec. Lt. & Power			7500			3500	
Insulation			700			1200	
Fireproofing			140			700	
Painting			500			2500	
Mach. Handlg. Equip.			450			75	
Scaffolding			200			400	
Testing			–			500	
Frt. & Cartage			750			250	
Piping			38000			31000	
Miscellaneous			7410			7625	
Total Direct Cost			139000			79500	
Construct. Incid.			7000			8500	
Sub Total			146000			88000	
Contract Charges			–			81000	
Total Estimated Cost			$146000			$169000	$315000
Preliminary Est. of Cost			$160000			$197000	$357000

FIG. 12

ESTIMATE OF COST

EST. NO. _____ SHEET NO. 1 of 3
ENG'R'S. EST. _____

LIGHT OIL TREATING UNIT
3700 BPOD
CHECK ESTIMATE SUMMARY

PLANT NAME Plant "M"
DWG. NO'S. _____ COMPUTED BY GEB DATE Oct. 28, 1949

ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
Foundations			6000			9000	
Pumphouse			10500			9500	
Struct. Steel			3900			1300	
Shell & Tube Equip.			1550			300	
Vessels & Drums			19000			2000	
Pumps & Drivers			6200			2000	
Instruments			13000			6500	
Lights & Power			5700			3700	
Insulation			3700			1200	
Fireproofing			100			500	
Painting			300			1500	
Trolleys & Hoists			250			25	
Scaffolding			200			400	
Testing			–			400	
Freight & Cartage			700			300	
Pipework			25000			20000	
Miscellaneous			5500			6875	
Total Direct Cost			101000			65500	
Construction Incidentals			5000			6500	
Sub Total			106,000			72000	178,000
Contract Charges			–			60000	60,000
Total Estimated Cost			$106,000			$132,000	$238,000
Preliminary Est. of Cost			$95,000			$115,000	$210,000

FIG. 13

erates so that when insulation is figured later the proper thickness can be selected when accumulating the areas of the towers requiring insulation.

Trays and packing should be estimated from the area of the individual trays and the number of trays or the cubic feet of packing required. While carbon Raschig rings run about $6 per cubic foot and require roughly one man-hour per cubic foot to install, trays will vary according to the type of material used. Carbon steel trays run about $.27 per pound while 4-6 per cent chromium steel trays cost about $.55 per pound. The actual price differential is not that great however, as the alloy trays will weigh only about 5/6ths as much as the same size steel trays. Installation of trays takes about 2 man-hours of labor per square foot of tray for small towers 3 or 4 feet in diameter up to 1-1½ man-hours per square foot for the larger towers.

Horizontal pressure vessels or drums should be estimated in the same manner as described for towers but unit costs per pound will be lower since the large number of nozzles and manways and tray supports found on fractionating towers will not be required ordinarily on accumulator drums and the like.

It should be apparent by now from the foregoing description of the individual steps in preparing the check estimate that the same principles are involved for each subdivision as were utilized when estimating the processing unit as a whole. The theory being that by breaking the main estimate down into a large number of components each of which is examined more closely and priced individually with greater accuracy, the final cost for the project will be more accurate. It is assumed that plus and minus errors will tend to balance out and that the theory of probability is working in the estimator's favor.

At the close of Article 2 of this series a preliminary estimate of cost was developed for providing three light oil treating units. Illustrated in Figs. 12 and 13 are the summary sheets from the check estimates prepared on two of these units. It will be noted from the check estimate results that while the larger unit seems to have been overestimated by $42,000 the smaller unit was underestimated $28,000, making a net overestimate of $14,000 in the preliminary try. This is only about 3 per cent of the $553,000 involved and far better than can be expected in most cases. Comparing the preliminary estimates against the check estimates for the individual units, it appears as though the original estimates were about 15 per cent off in each case but in opposite directions. Of course the true cost will not be known until the job has been completed, but if the estimator is within 15 per cent of the final actual cost with his last check estimate he should be well satisfied. In this particular instance a straight line drawn on the chart in Fig. 9 of Article 2 between the two values determined in the check estimates intercepted the capacity rating for the third unit at practically the same cost point as was found previously and no check estimate was felt to be necessary for that unit.

In this short series on estimating plant costs a system that has proved satisfactory for the author's purpose in estimating construction costs in the petroleum industry has been described. It may not prove to be applicable to estimating for the process or chemical industries in general, but it is hoped that by describing it the reader may be stimulated to adapt some of the steps or methods to his own use and thereby profit. * * *

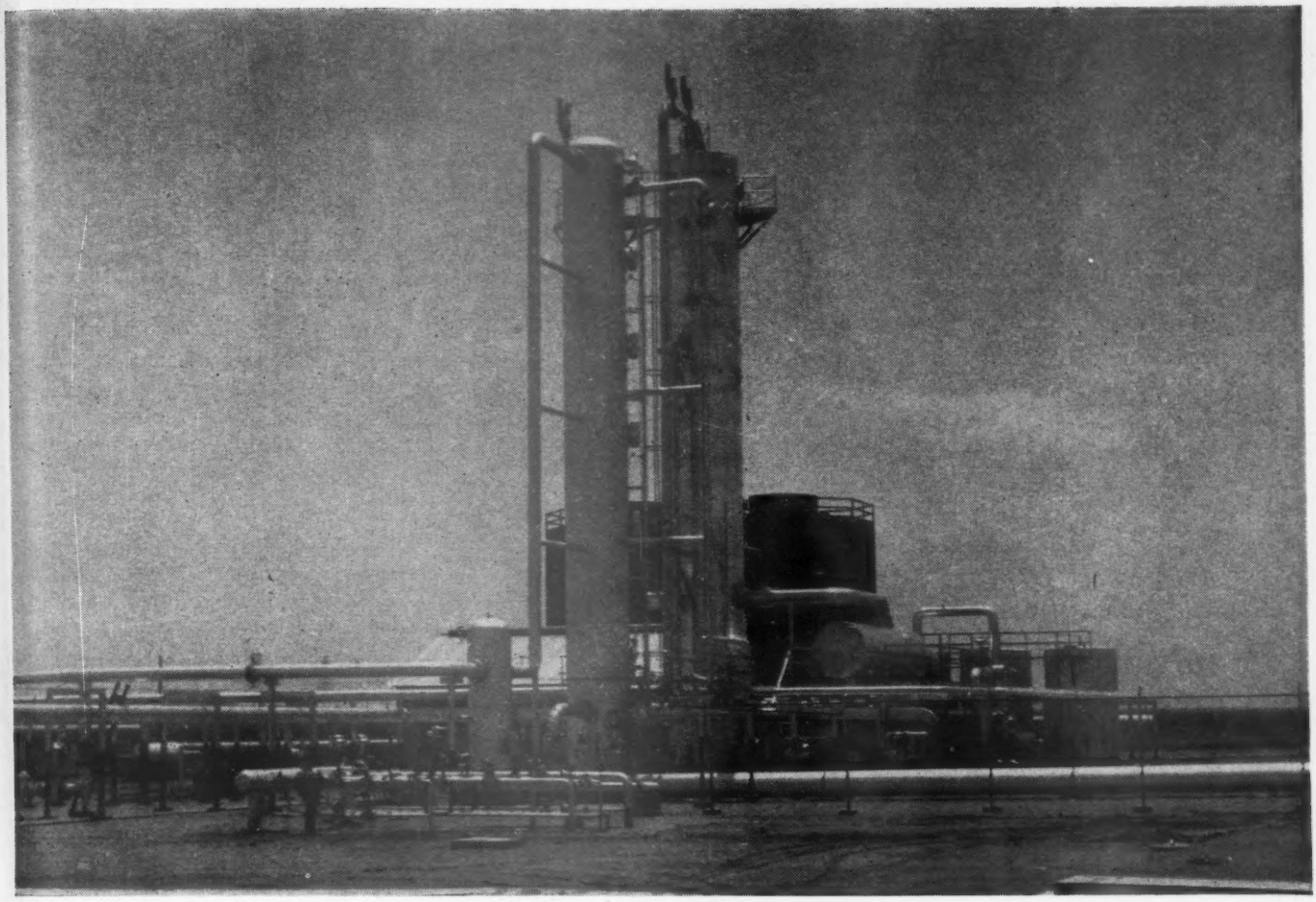


FIG. 1. Typical glycol-amine gas treating plant.

Technical Aspects of Glycol-Amine Gas Treating

ARTHUR L. KOHL* and CLYDE L. BLOHM*

Purifying 400,000,000 Std Cu Ft per Day of Gas to Meet California's Stringent Law, With Monoethanolamine and Diethylene Glycol.

THE glycol-amine process for the simultaneous purification and dehydration of gas has been adequately described in the literature[2,3,5]. As is the case with many valuable processes, however, very little actual plant data have been presented. Herein the authors present data obtained during a recent comprehensive testing program on the treating plants of the El Paso Natural Gas Company. The tests covered seven high pressure plants having a combined capacity of over 418,000,000 std cu ft per day of natural gas. Treated gas from these plants is supplied to El Paso Natural Gas Company's pipe line connecting the West Texas and New Mexico oil fields with the Southern California area[10]. The inlet gas to the treating plants varies considerably in composition, but the purified gas must meet the stringent California requirement of less than 0.25 grain of H_2S per 100 std cu ft and, in addition, must be dehydrated sufficiently to preclude the possibility of hydrate formation in the transmission lines. The tests revealed that in general the overhead gas from these plants actually contained less than 0.1 grain of H_2S per 100 std cu ft (0.00016 mol per cent).

*The Fluor Corp. Ltd.

EXCLUSIVE

Nature of Process

All of the treating plants tested employ a typical glycol-amine flow system as shown in Fig. 2, using solutions containing from 10 to 30 per cent monoethanolamine and 5 to 10 per cent water. Treating of the gas is accomplished in a bubble cap column in which the solution of amine, diethylene glycol and water is made to pass downward countercurrent to the gas stream that is admitted at the bot-

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Arthur L. Kohl is senior research chemical engineer for the Fluor Corporation, Ltd., with whom he has been associated since June, 1947. He holds a bachelor's degree in chemical engineering from the University of Southern California, which was granted with highest honors in 1943, and an MS, which he obtained in 1947. During his undergraduate period and in the year following, he conducted research for Turco Products Inc., primarily in the field of magnesium alloy surface treatment and corrosion protection. He spent two years in the Army, the first as an enlisted man and the second (after O.C.S. in Louisiana) as a transportation officer on transports plying the Pacific. At Fluor, he has been intimately concerned with the procurement and correlation of design data and the development of new processes in the general fields of gas treating and petrochemicals.

C. L. Blohm

Clyde L. Blohm is a graduate of the California Institute of Technology, where he received his BS in 1930 and his MS in chemical engineering in 1931. Following his graduation he was employed consecutively by Canada Dry Gingerale, Inc., Chemical and Research Corporation, American Potash and Chemical Corporation and Maier Brewing Company in the capacity of chemist and chemical engineer. In 1936 he joined Gordon A. Alles, Ph. D. where he was active in research on synthetic pharmaceuticals and pharmacology. He joined Fluor in 1942 where he is at present assistant director of research. Under his supervision research has covered a large number of problems such as desulfurization and dehydration of hydrocarbon gases, studies of hydrocarbon hydrates, corrosion resistance of metals, evaporative water cooling, general wood chemistry as applied to cooling towers and development of equipment such as pulsation dampeners, gas cleaners, mufflers, etc.

tom. Gas leaving the top of the contactor is essentially free of H_2S and CO_2 and is dehydrated to a predetermined degree established by plant operating conditions. The rich glycol-amine solution leaving the bottom of the contactor is heated by exchange with the lean solution and introduced at a centrally located feed point into a second bubble cap column, which serves as a still. The solution passes down through the stripping section of the still to the reboiler where sufficient heat is supplied to heat the entering solution, liberate the acid gas content, and evaporate the quantity of solution required for stripping vapor. Essentially all of the acid gas is evolved in the stripping section of the still at the expense of water vapor, which condenses to supply the heat of reaction. The acid gas stream leaving the top of the still is passed through a condenser and condensate accumulator from which reflux for the still is usually obtained. The reflux serves to knock back amine and glycol in the rectifying section of the still above the feed tray and to provide stripping vapor when revaporized. Hot regenerated glycol-amine solution from the reboiler passes back through the heat exchanger, giving up a portion of its heat to the rich solution, and is then pumped through coolers and back to the top of the contactor.

Plant Test Conditions

In general, plant tests were intended to be at design gas flow rate and the minimum circulation rate of amine solution necessary to produce gas that would pass the purity specifications. As the acid gas content of the feed to all plants was somewhat below the design figure, this resulted in a solution rate lower than that for which the plants were designed; however, in the interest of evaluating the mechanical capacity of the equipment, some runs were made with the solution rate higher than the design value.

All of the treating plants were on stream during the tests and effluent sour gas could not be tolerated. This meant that any alteration of operating conditions had to be accomplished very cautiously and the actual minimum flow of solution could only be approached. Fluctuation of the inlet gas rate to the plants contributed to the operating sensitivity and made it necessary to maintain a considerable margin of safety in the solution flow rate.

The general procedure for testing each plant consisted of:

1. Preparing the plant by installing pressure gages, thermometers, and sample connections where necessary, and checking installed instrumentation where needed.
2. Lining out the plant by gradually approaching the desired conditions and holding the conditions as steady as possible for several hours while taking hourly logs.
3. Sampling the liquid streams for subsequent analyses and analyzing gas streams. As two to four hours were usually required to complete the gas analyses, operation conditions were maintained constant and plant operations logged regularly during the testing period.

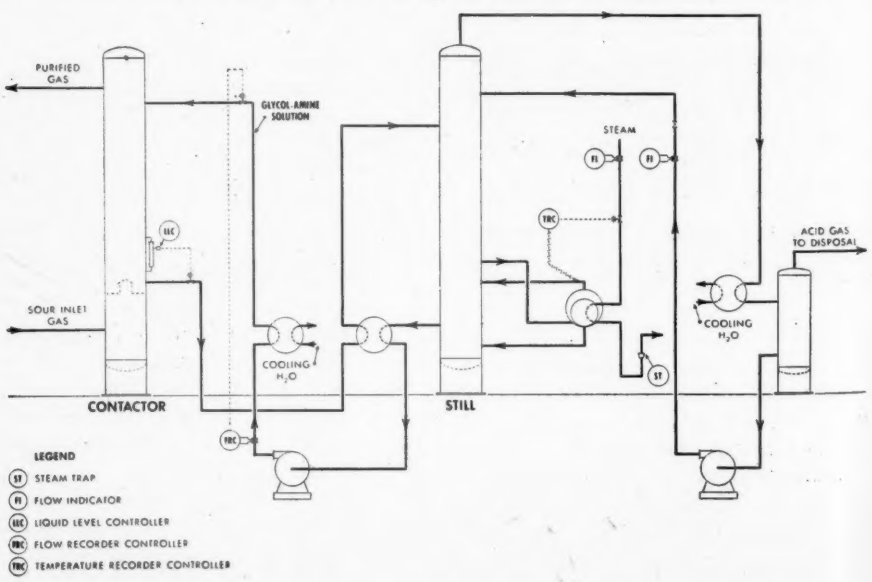
Analytical Procedures

The minimum samples analyzed for each plant test consisted of:

1. Inlet gas to contactor.
2. Sweet gas from contactor.
3. Lean amine solution.
4. Rich amine solution.
5. Acid gas from still.
6. Still overhead condensate.

In addition, samples were taken oc-

FIG. 2. Typical flow diagram of glycol-amine gas treating process.



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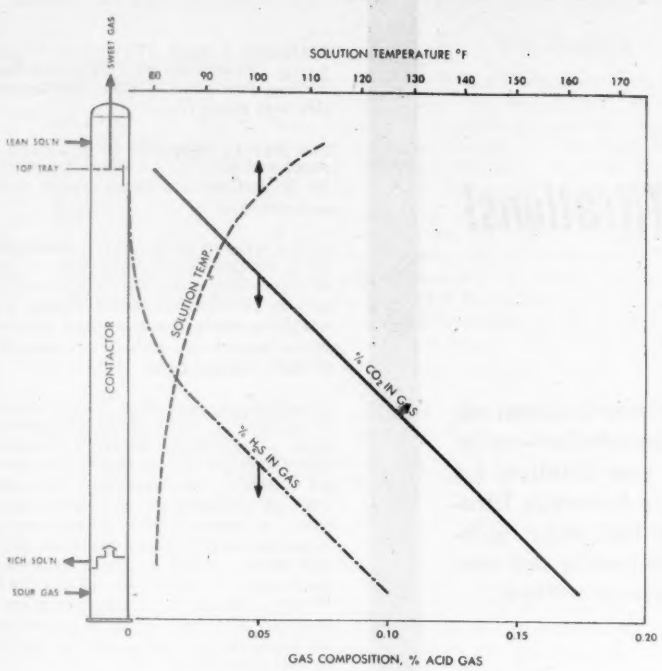


FIG. 3. Gas composition and temperature profile of contactor during run E-13.

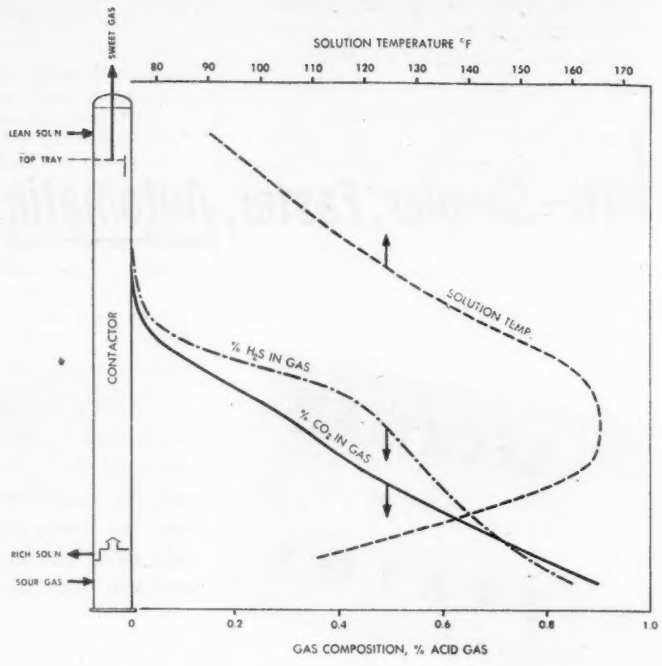


FIG. 4. Gas composition and temperature profile of contactor during run G-17.

casionally of the rich solution after it had passed through the heat exchanger to determine the nature and quantity of gas evolved prior to the actual stripping stage; and of the solution passing from the still to the reboiler to evaluate the composition changes occurring during stripping. For composition profiles, gas and liquid samples were taken where possible from intermediate trays on the contactors and stills. Samples were analyzed during or immediately following the testing operations. The following analytical methods were utilized:

1. Orsat analysis with 40 per cent KOH for determining the total acid gas content of gas streams containing on the order of 1 per cent or more acid gas.

2. Tutweiler[11] analysis for the hydrogen sulfide content of gas.

3. Acidified cadmium sulfate method[6] for the determination of small concentrations of hydrogen sulfide in the presence of mercaptans.

4. Lead acetate paper test for hydrogen sulfide in gas[7].

5. Blohm-Riesenfeld method for the simultaneous determination of hydrogen sulfide and carbon dioxide in a continuous gas stream[4].

6. Distillation with toluene for determination of the water content of glycol-amine solutions. The method used is a modification of the ASTM procedure for the determination of water in petroleum products[1].

7. Standard acid titration for the determination of the amine content of liquid samples.

8. Evolution method for determining the total acid gas content of amine solutions. The acid gas content is evolved with concentrated phosphoric acid in a specially designed apparatus[8].

As the above analytical procedures have been adequately described in the literature or are based upon well established operations, more complete descriptions will not be given in this paper.

Gas Contacting Stage

The heart of the glycol-amine gas treating process is the contactor in which the hydrogen sulfide, carbon dioxide, and water vapor are absorbed from the sour gas. Although the three components are absorbed in a single solution, quite dissimilar reaction mechanisms are involved.

Hydrogen sulfide reacts with monoethanolamine to form the sulfide and acid sulfide, whether or not water is present, according to the following reactions:

$$2\,RNH_2 + H_2S \rightleftarrows (RNH_3)_2S \quad . . . . . (1)$$

$$(RNH_3)_2S + H_2S \rightleftarrows 2\,RNH_3HS \quad . . . . . (2)$$

where R represents the group—
CH_2CH_2OH.

An appreciable heat of reaction is evolved during the absorption and the final product is a real salt that has been isolated and crystallized in the laboratory. The reactions are reversible, shifting to the left with increased temperature; however, even at room temperature, monoethanolamine sulfide exerts an appreciable vapor pressure of H_2S. Because of this, it is necessary that the solution entering the top of the column be practically free of hydrogen sulfide where extremely sweet gas is required.

As carbon dioxide is the anhydride of an acid, it cannot react to form the carbonate or bicarbonate unless water is present. In the absence of water, however, it may react with monoethanolamine directly to form a carbamate. As only a small amount of water is present in the glycol-amine solution, most of the carbon dioxide is believed to go to the carbamate by the following reaction:

$$2\,RNH_2 + CO_2 \rightarrow RNHCOONH_3R \quad . . . . . (3)$$

Even in aqueous solutions, there is evidence to indicate that a considerable portion of the CO_2 reacts directly with the monoethanolamine as shown above. However, some hydration occurs with the formation of carbonate and bicarbonate as follows:

$$2\,RNH_2 + CO_2 + H_2O \rightarrow (RNH_3)_2CO_3 \quad . . . . . (4)$$

$$(RNH_3)_2CO_3 + CO_2 + H_2O \rightarrow 2\,RNH_3HCO_3 \quad . . . . . (5)$$

The reactions of monoethanolamine with carbon dioxide liberate a great deal of heat and the compounds formed are more stable than the sulfides (although not as readily crystallized) so that the partially saturated solutions exhibit a practically negligible partial pressure of carbon dioxide at reasonably low temperatures. In fact, even at moderately elevated temperatures, the rate of absorption of CO_2 in the contactor may be increased by the effect of temperature on viscosity and reaction rates instead of decreased by the shifting equilibrium. The absorption of H_2S, on the other hand, may be slowed down or reversed at the same point in the column by the effect of temperature on vapor pressure.

Dehydration of the gas stream by glycol-amine solutions has been found to be slightly better than the dehydration obtained with equivalent solutions containing diethylene glycol alone, which is not surprising in view of the fact that monoethanolamine is an excellent dehydrating agent. However, as pointed out by Riesenfeld and Frazier[9], the dew point of the gas effluent from liquid treaters has little significance because of the presence of amine and diethylene glycol in the vapor phase. Of considerably more importance is the observed fact that no hydrate difficulties have ever been encountered in the transmission lines served by the described treating plants.

Figs. 3, 4, and 5 illustrate the analytical and temperature profiles of three different contactors with regard to the concentration of H_2S and CO_2 in the gas and the solution temperature. As the graphs are drawn against an ordinate scale that represents the number of trays in the column, and as these trays are uniformly spaced, the slopes of the analytical profile lines indicate rates of absorption. The plants varied widely in acid gas composition and the data clearly illustrate the interdependence of the two acid gas components with regard to absorption rates and their effect upon the temperature profile.

Fig. 3 illustrates the case of a column operating with an inlet gas containing only 0.10 per cent H_2S and 0.18 per cent CO_2, which entered at the unusually low temperature of 75 F. Because of the low acid gas content, a very low solution rate was required and the flowing gas had a much higher total heat capacity than the liquid. The gas, therefore, cooled the solution in the column and in addition absorbed all of the heat of reaction so that it left the column at about 100 F. The solution in this instance actually left the column at a lower temperature than that at which it entered. The CO_2 is noted to have been absorbed at a fairly constant rate, which was probably the result of a balance between decreasing partial pressure of CO_2 and increasing solution temperature as the gas passed up the column. The plant represents one of the few instances where an appreciable carbon dioxide content of the outlet gas could be detected (0.01 per cent), a fact that is probably explainable on the basis of the unusually low solution temperature prevalent throughout the length of the column. H_2S absorption appeared to be approximately proportional to partial pressure over the length of the column and the outlet gas was found to contain approximately 0.09 grain of H_2S per 100 std cu ft.

Fig. 4 is the profile of a contactor operating on a gas containing about 0.9 per cent each of H_2S and CO_2. Because of the higher acid gas content, a proportionately higher solution flow rate was required, having a gross heat capacity slightly higher than that of the flowing gas. Because of this, the heat of reaction was largely taken up by the solution that attained a temperature of 165 F in the column, although it left at 112 F after being cooled by the incoming gas. Carbon dioxide absorption appeared to be rapid over the length of the column and any quantity present in the outlet gas was below the limit of accuracy of the analytical method used. Although hydrogen sulfide was absorbed from the gas through the entire column, the quantity absorbed per tray dropped off in the region of the heat bulge and then increased again in the cooler region and finally decreased in proportion to the decreasing partial pressure near the top of the column. The outlet gas from this plant contained 0.2 grain H_2S per 100 std cu ft during the run.

Fig. 5 represents the case of a column operating on an inlet gas containing a relatively large fraction of CO_2 and H_2S. As a large volume of solution was required relative to the

FIG. 5. Gas composition and temperature profile of contactor during run A-4.

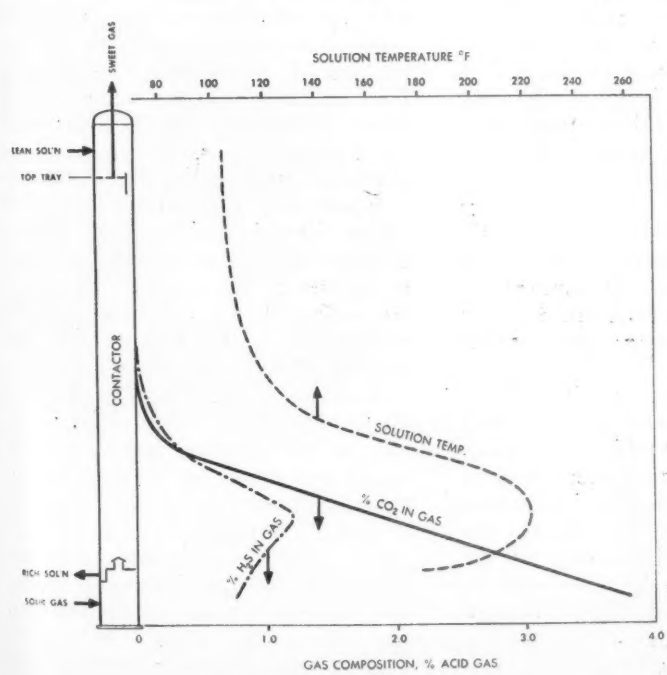
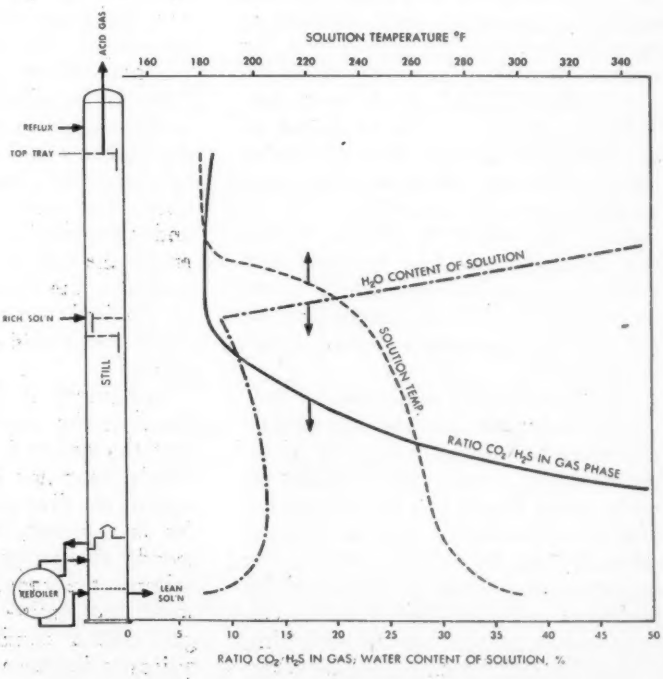


FIG. 6. Composition and temperature profile of still and reboiler during run A-2.



quantity of gas involved, the heat capacity of the gas stream was negligible compared to that of the solution and the entire heat of reaction was removed by the liquid, which attained a maximum temperature of 222 F a few trays above the bottom and left the column at 178 F. In this column the carbon dioxide was absorbed at an almost constant rate in the area of the heat bulge while the hydrogen sulfide was actually stripped from the solution in this zone. The gas phase was found to increase in hydrogen sulfide content over the lower section of the column indicating that recycling of this component occurred. Above the high temperature zone the hydrogen sulfide content of the gas dropped off rapidly and the product gas from the column was found to contain only 0.04 grain of H_2S per 100 std cu ft.

It is interesting to note that an amine treater designed to handle an extremely acidic inlet gas is more apt to produce a cool overhead product than one handling an inlet gas containing little CO_2 and H_2S due to the relatively larger volume of solution required. The outlet gas temperature is, of course, very important from the standpoint of dehydration and amine vaporization loss, so an accurate knowledge of the effect of process variables on this factor is essential to the proper design of gas treating plants.

Table 1 gives pertinent data on acid gas absorption in the contactor during testing operations on the seven treating plants.

TABLE 1. Contactor operating data.

Plant	Run	Gas rate MMSCF/D	Contactor pressure PSIA	Sol. flow rate GPM	Inlet gas composition		Outlet gas composition	
					% H_2S	% CO_2	H_2S Gr./100 SCF	% CO_2
A	1	50.9	542	450	0.74	3.9	0.06	0.00
A	2	63.9	537	465	0.72	4.0	0.03	0.00
A	3	63.5	533	445	0.71	4.1	0.05	0.00
A	4	63.5	536	441	0.76	3.8	0.04	0.00
A	5	63.5	533	450	0.84	3.9	0.05	0.00
A	6	63.5	533	451	0.76	3.8	0.06	0.00
A	7	64.0	533	451	0.76	3.8	0.06	0.00
B	8	86.5	533	347	0.34	1.66	0.02	0.00
B	9	86.0	535	341	0.35	1.45	0.04	0.00
B	10	87.8	537	354	0.34	1.68	<0.25	.....
C	11	68.5	523	123	0.12	0.42	0.06	0.00
D	12	41.6	518	169	0.12	0.43	0.04	0.00
E	13	50.7	538	32.2	0.10	0.18	0.09	0.01
F	14	44.9	596	191	0.10	0.46	0.06	0.00
F	15	45.1	603	61.8	0.09	0.41	<0.25	....
F	16	44.2	596	191	0.11	0.38	<0.25	....
G	17	34.5	558	146	0.86	0.90	0.20	0.00

TABLE 2. Still and reboiler operating data.

Plant	Run	Acid gas stripped MSCF/D	Steam used M lb/H	Still pressure PSIA	Temperatures		Reflux rate GPM	Lean soln. composition	
					Soln. from Reboiler °F.	Still top		H_2S Gr./Gal.	CO_2 Cu. Ft./Gal.
A	1	2,300	29.9	18.5	300	187	12.2	6	0.05
A	2	3,000	30.2	19.0	300	178	11.0	4	0.04
A	3	3,100	29.1	19.0	300	176	11.0	5	0.03
A	4	2,900	29.6	19.3	300	179	11.0	4	0.06
A	5	3,000	25.6	18.2	300	150	1.9	10	0.54
A	6	2,900	31.2	19.1	300	181	11.0	5	0.12
A	7	3,000	30.9	19.9	300	181	11.1	7	0.04
B	8	1,700	22.6	....	312	...	9.4	5	0.003
B	9	1,600	22.7	16.2	312	...	9.7	2	0.009
B	10	1,800	23.2	16.3	312	181	9.1	3	0.007
C	11	370	....	15.5	293	145	1.8	19	0.10
D	12	230	....	15.5	293	145	1.8	19	0.10
E	13	140	....	23.0	302	202	....	12	0.03
F	14	250	9.0	14.8	297	179	3.6	3	0.00
F	15	230	7.0	14.5	305	174	3.6	3	0.008
F	16	220	8.7	....	300	180	3.7	2	0.009
G	17	610	8.2	19.8	295	189	3.7	8	0.00

Stripping Stage

Data on the performance of the stills and reboilers are given in Table 2. It will be noted that in general the analyses showed the lean solutions to contain less than 15 grains H_2S per gallon. Actually, however, it is believed that the H_2S levels were considerably below the values found as the titrations for H_2S were performed upon unfiltered solutions that contained suspended iron sulfide. The extremely low values for CO_2 content of the lean solutions and the fact that sweet gas was produced readily in the contactors are sufficient proof that excellent stripping was obtained in all of the plants.

The phenomena encountered during the stripping operation can best be explained by following the path of the rich solution through the still and reboiler using Fig. 2 and the still profile Fig. 6 as references. After pressure is released from the solution leaving the contactor and while it is heated by exchange with the lean solution, an appreciable portion of the stripping occurs. Essentially all of the dissolved hydrocarbons are evolved plus a fraction of the acid gas determined by the degree of saturation of the solution, the quantity of hydrocarbon available and the temperature attained in the exchanger. The ratio of H_2S to CO_2 in the gas evolved prior to the still is found to be higher than that occurring in the original rich solution because of the higher volatility of H_2S relative to CO_2 over hot monoethanolamine solutions. The mixture of evolved gases and glycol-amine solution commonly enters the still at about 240 F, which is close to the equilibrium temperature on the feed tray as determined by the vapor and liquid compositions at that point.

Conditions in the still differ from those in the contactor to the extent that the gas and liquid phases more nearly approach equilibrium and, of course, the direction of acid gas transfer is reversed. As the solution descends the stripping section of the column, the vapors become richer in water and amine and leaner in acid gas, which condition obviously requires an increase in temperature. It is also noted that the ratio of CO_2/H_2S in the gas phase increases down the column. The heat of reaction required to evolve the acid gases from the solution is provided by condensing vapors, predominately water, so that the water content of glycol-amine solution is found to increase as the solution flows down through the still. In a properly designed and operating glycol-amine plant, essentially all of the acid gas is stripped from the solution before it enters the reboiler, and the vapors from the reboiler to the still are found to consist of the mixture of water, monoethanolamine and diethylene glycol that is in equilibrium with the lean solution at its boiling point.

Although it has been found possible to perform a portion of the stripping in the reboiler, experience has taught that the ability to strip the solution completely in the still represents a definite advantage of the glycol-amine system over aqueous plants because of the possibilities of corrosion where acid gases are liberated on the surface of hot tubes. It is believed that the better stripping obtained with

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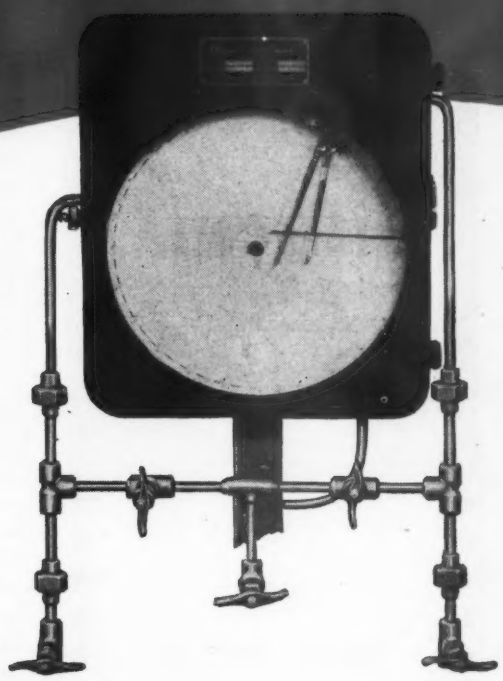

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glycol-amine solutions is due primarily to the higher temperature attained in the still and reboiler; however, there is further evidence to indicate that the compounds formed by acid gases and amines in the presence of water are decomposed with more difficulty than those formed in an essentially water free solution. Carbon dioxide in particular, which is known to form a different compound with monoethanolamine in the presence of water, is practically impossible to strip completely from a simple aqueous monoethanolamine solution under reasonable operating conditions.

In the upper section of the still, rectification is accomplished by refluxing with water or still overhead condensate, which results in practically complete knockback of volatilized monoethanolamine or glycol. The top temperature of the still can be estimated from steam tables on the basis of the calculated partial pressure of the water vapor contained in the acid gas stream. Most of the water vapor in the still overhead gas is usually condensed and pumped back to the top of the column as reflux. In practically all of the plant tests, this liquid was found to contain less than 0.1 per cent monoethanolamine. In most plants, the overall water balance is maintained by the fact that the water added by the dehydration reaction is approximately offset by the water lost in the disposal acid gas stream.

Conclusion

In addition to the detailed data on acid gas absorption and stripping operations, a considerable quantity of miscellaneous data were accumulated relative to glycol-amine plant operation. Pressure drop data, for example, on contactors and stills substantiated the methods used for design. Checks of operating heat transfer coefficients and equipment sizing indicated satisfactory agreement with design specifications.

Since the described testing operations on the plants of the El Paso Natural Gas Company were completed, several additional glycol-amine units have been put in operation. Although the basic principles remain the same, the later plants have benefited to a considerable extent by the fund of information gathered during this and other field testing programs. The number of usable flow schemes has increased to the extent that an economic study is now justified for each proposed plant. On the basis of such studies, plants have been designed utilizing various solution compositions and liquid flow systems to secure maximum economy with regard to investment and operating costs.

The authors wish to express their appreciation to the engineering and operating personnel of the El Paso Natural Gas Company for their cooperation in permitting the use of their plants in making these tests possible, and, in addition, to B. B. Kuist, F. C. Riesenfeld, and H. D. Frazier of the Fluor Corporation engineering and research staffs for their assistance in the prosecution of the testing program and gathering of the data presented. Finally, the authors wish to thank the managements of both the El Paso Natural Gas Company and the Fluor Corporation for permitting this publication of the test results.

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New Uses of Petroleum

The newest oil products for farms are in the form of petrochemicals. A list of all the new petrochemicals and their present and potential farm uses would fill a book. Here are a few:

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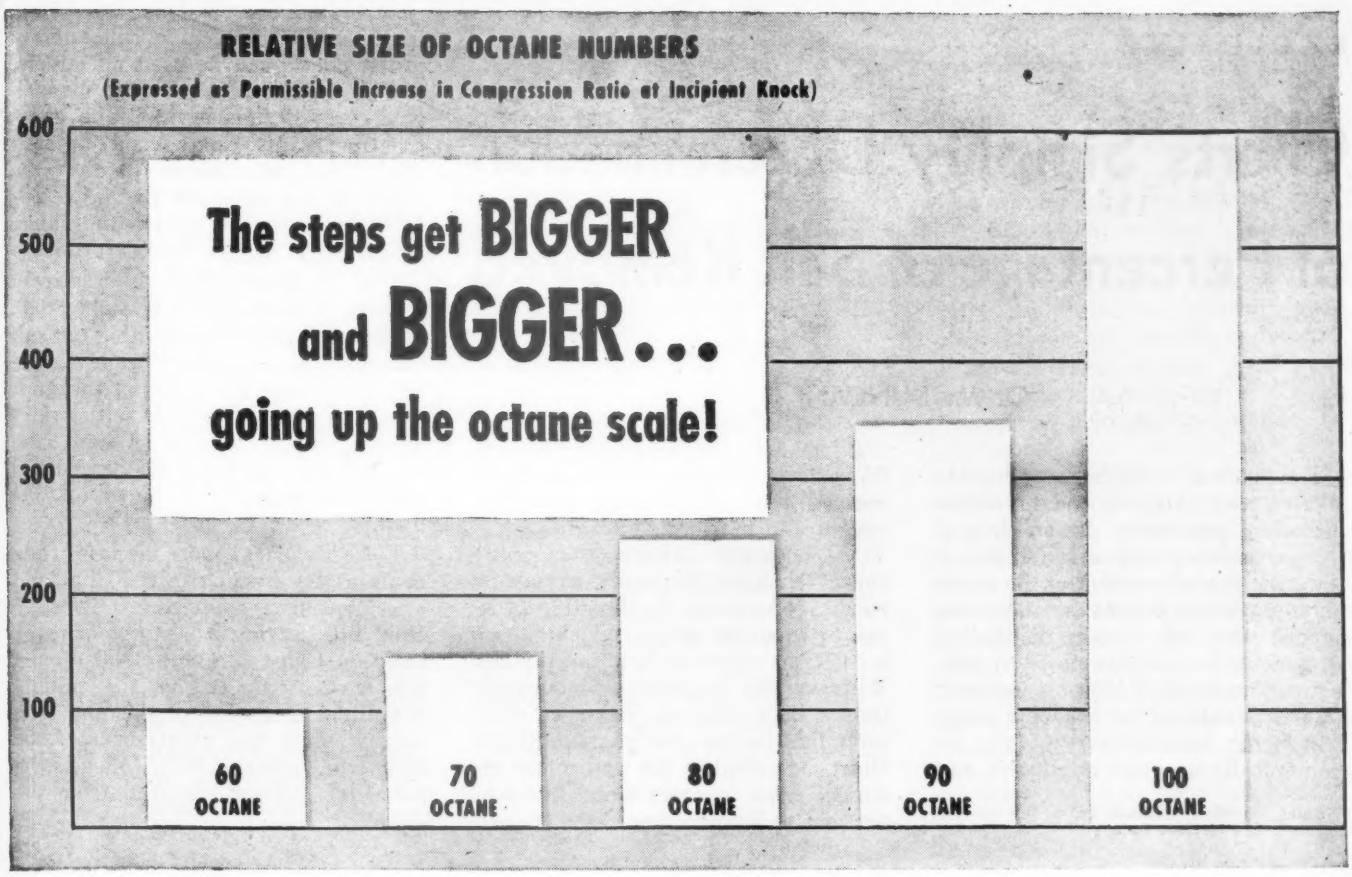


THE Octane Scale is a useful tool for the control of gasoline quality. However, it does not give a complete indication of what fuels can deliver in an engine.

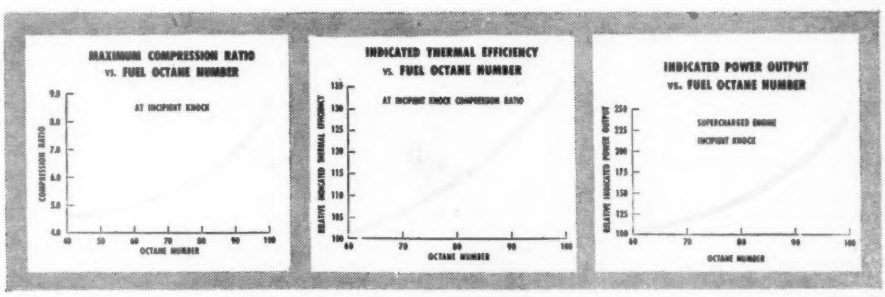
On the Octane Scale one unit appears to be equal in size to every other unit. But in terms of actual engine performance, octane units at different levels vary greatly in size.

For example, expressed as *permissible increase in compression ratio* (bar chart above), one octane unit at the 90 level is 3.5 times as large as at the 60 level. At the 100 octane level, a unit is 6 times as large as at the 60 level. In other words, the steps up the octane scale get larger and larger.

Complete evaluation of the quality of gasoline requires measurement not only in terms of octane numbers but also in terms of scales based on those factors of engine performance dependent on antiknock quality. Three such factors are permissible compression ratio, thermal efficiency and power output. The three charts below show the relation between octane number and these engine factors.

Each chart shows that in terms of potential engine performance, octane numbers get "bigger" and more valuable going up the scale.

When reviewing the economics of gasoline production, refiners might profitably think not solely in terms of octane numbers but in terms of scales of antiknock quality based on the three factors of engine performance—maximum permissible compression ratio, thermal efficiency, and maximum power obtainable.



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The removal of salt from crude oil to prevent tray plugging and to reduce corrosion materially is an important preliminary step in oil refining. Lowering the salt content of the crude not only reduces down-time and maintenance cost on crude distillation equipment, but similar costs of subsequent cracking of bottoms and side streams is reduced for cracking units.

In some installations it may be economically unsound to attempt, say 95 per cent removal, but the optimum removal for each apparatus should be sought and the limits known.

In refineries where the crude source changes frequently it may be necessary to check the desalting process, of whatever nature, once or twice a shift; in others once a day suffices. Whatever the frequency of laboratory tests a little time can be saved after each test by the use of nomograph charts to calculate the percentage removal. Even in cases where the laboratory technician has been trained in the use of the slide rule, nomograph charts can be used effectively.

Two charts are shown here which have proved themselves to be effective time savers. Chart A may be used where the salt content of the raw crude is not over 50 lb NaCl per 1000 bbl. Chart B covers the range 50 to 100 lb salt in the raw crude.

Use of these charts is relatively simple. By means of a straight edge, connect the point representing the salt content of the untreated crude on the left curve with the point on the middle curve representing the salt content of the treated crude. Where the straight edge crosses the percentage curve, the percentage removal may be read.

For example, suppose the raw crude contains 80 lb salt per 1000 bbl and after desalting contains 10 lb salt/1000 bbl. Laying a straight edge or ruler on Chart B, connect 80 on the left curve with 10 on the middle curve. An extension of the line connecting these two points crosses the right hand curve at 87.5, which is the percentage of salt removed from the crude. * * *

*Chief Chemist, Indiana Farm Bureau Cooperative Association, Inc.

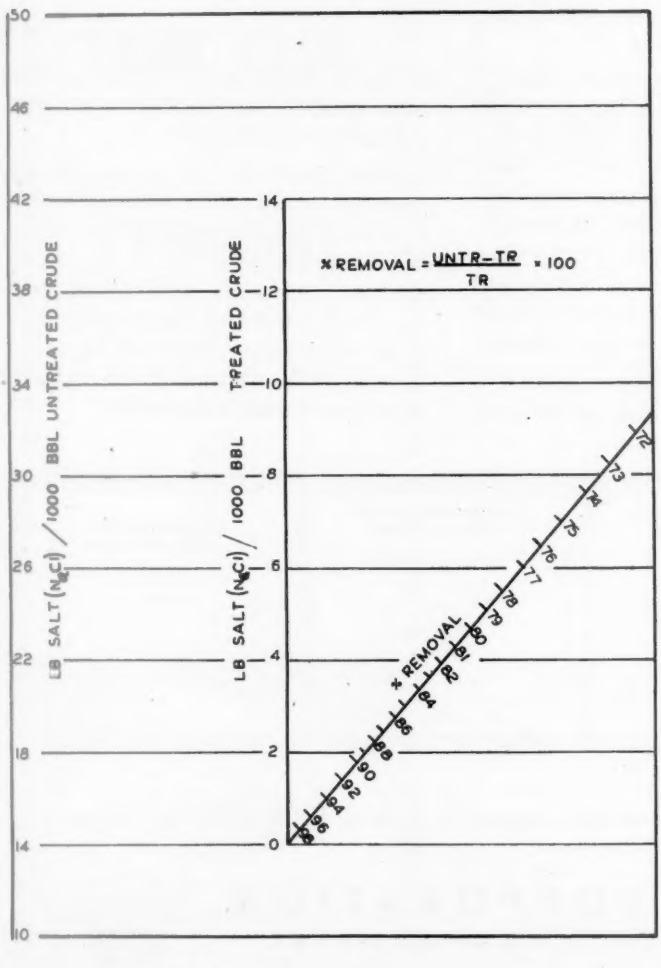


CHART A

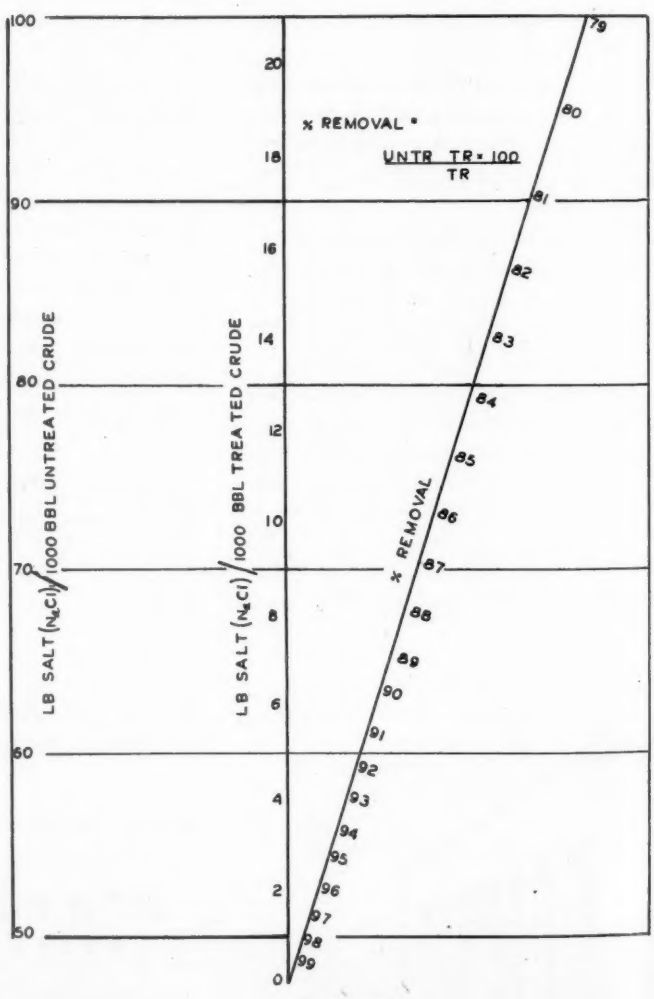


CHART B

Oil Refinery Industry in Japan During 1949

Many Plants Were Rehabilitated and Placed In Operation at Beginning of This Year

SEVERAL significant developments in the oil refining industry in Japan took place during 1949, according to a report from General Headquarters, Supreme Commander for the Allied Powers. The report was prepared by the Natural Resources Section.

In July 1949, SCAPIN 2027 was issued rescinding restrictions on refining of crude petroleum in Pacific Coast refineries excluding ex-military refineries. The Japanese Government was instructed to submit recommendations for repair and rehabilitation of refineries proposed for operation.

This was followed in November 1949, by SCAPIN 6983-A, which was issued to the Japanese Government approving the latter's plan for repair and rehabilitation of the Pacific Coast refineries as follows:

1. The Nippon Oil Company refinery at Yokohama, Kanagawa Prefecture, the Nippon Oil Company refinery at Kudamatsu, Yamaguchi Prefecture, the Showa Oil Company refinery at Kawasaki, Kanagawa Prefecture, the Toa Nenryo Company refinery at Shimizu, Shizucka Prefecture, were all instructed to be placed in operable condition as soon as possible but no later than January 1, 1950. Each of the above refineries was to be capable of receiving and processing imported crude oil at the rate of 4000 bbl per day into a complete line of refined products.

2. The Daikyo Oil Company refinery at Yokkaichi, Mie Prefecture, was instructed to prepare to receive and process fuel oil at the rate of 1000 bbl per day into lubricating oils and asphalt.

3. Approval was also given for repair and rehabilitation of the Maruzen Oil Company refinery at Shimotsu, Wakayama Prefecture, to prepare to receive and process imported crude oil at the rate of 3000 bbl per day into a full line of refined products not later than April 1, 1950.

4. The Toa Nenryo Company refinery at Wakayama, Wakayama Prefecture, was authorized to repair and rehabilitate in preparation for receiving and processing imported crude oil at the rate of 6000 bbl per day into a full line of refined products no later than July 1, 1950.

5. Approval was also given for repair and rehabilitation of only existing facilities at the Mitsubishi Oil Company refinery at Kawasaki, Kanagawa Prefecture, and the Koa Oil Company refinery at Marifu, Yamaguchi Prefecture, in anticipation of cracking stock for these refineries.

Up to April 1950, two crude oil purchases for Japan of 960,000 and 2,040,000 bbl, respectively, have been made by the Armed Services Petroleum Purchasing Agency in Washington. In addition, 720,000 bbl have been procured through private import from the sterling area. These purchases will permit operations in 6 Pacific Coast refineries through June.

At the present writing, 5 refineries are in operation and 2 others, Toa Nenryo's Wakayama refinery and Maruzen's Shimotsu refinery were scheduled to begin operations in April.

Action taken during 1949 was aimed at reducing imports of refined products as promptly as possible. To achieve this it is intended to import and process 25,000 bbl of crude oil per day in USFY 51. Imports of refined products were curtailed this March as domestically refined products from imported crude were available at that time in limited amounts. In a later stage of the refining program, it is planned to reduce imports of crude oil, also, as two refineries operating on cracking stock only are brought into operation. * * *

TABLE 1. Refineries in Japan.

Company, headquarters address	Location, of plant[1]	Total crude charging capacity, bbl daily	Cracking capacity, bbl daily	Daily crude runs end of 1949 bbl	Type of refinery[2]	Operating status
Refineries on Japan seacoast						
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Hokkaido ref., east of Sapporo City	252	.....	0[3]	Complete.....	Operating
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Akita ref., Akita City	3,962	.....	1,200	Complete.....	Operating
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Niigata ref., Niigata City	2,012	.....	635	Complete.....	Operating
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Kashiwazaki ref., Kashiwazaki City	1,258	.....	480	Complete.....	Operating
Showa Oil Co., Tsunohazu, Shinjiku-ku, Tokyo	Niigata ref., Niigata City	1,274	.....	482	Complete.....	Operating
Showa Oil Co., Tsunohazu, Shinjiku-ku, Tokyo	Hirasawa ref., south of Akita City Hirasawa-machi	943	.....	421	Complete.....	Operating
Nippon Mining Co., Nihonbashi Muromachi, Chuo-ku, Tokyo	Funakawa ref., west of Akita City Funakawa-machi	2,516	.....	767	Complete.....	Operating
Refineries on Pacific Ocean and Inland Sea Coasts						
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Yokohama ref., Yokohama City	5,000	.....	.....	Complete.....	Operations started Jan, 50[4]
Nippon Oil Co., Marunouchi, Chiyo-da-ku, Tokyo	Kudamatsu ref.	5,000	.....	.....	Complete.....	Operations started Jan, 50[4]
Showa Oil Co., Tsunchazu, Shinjiku, Tokyo	Kawasaki ref., Kawasaki City	5,000	.....	.....	Complete.....	Operations started Jan, 50[4]
Toa Nenryo Kogyo Oil Co. Nihonbashi, Chuo-ku, Tokyo	Shimizu ref., Shimizu City	5,000	.....	.....	Complete.....	Operations started Jan, 50[4]
Toa Nenryo Kogyo Oil Co. Nihonbashi, Chuo-ku, Tokyo	Wakayama ref., Wakayama City	10,000	.....	.....	Skimming & crk.	Repairing operations planned for April, 50[5]
Maruzen Oil Co. Shiba Mita-Shikoku-machi—Minato-ku, Tokyo	Shimotsu ref., north of Wakayama City, Shimotsu Machi	3,000	.....	.....	Complete.....	Repairing operations started for April, 50[6]
Maruzen Oil Co. Shiba Mita-Shikoku-machi, Minato-ku, Tokyo	Matsuyama ref., Matsuyama City, northern coast of Shikoku	11,800	.....	.....	Skimming.....	Shut down
Koa Oil Co., Marunouchi, Chiyeda-ku, Tokyo	Marifu ref., Iwakuni City	5,000 3,000	....	.....	Skimming & crk.	Repairing, date of operations undetermined
Mitsubishi Oil Co., Marunouchi, Chiyoda-ku, Tokyo	Kawasaki ref., Kawasaki City	5,000 2,500	.....	.....	Skimming & crk.	Repairing, date of operations undetermined
Daikyo Oil Co.	Yokkaichi ref.	1,500	.....	.....	Lube & asphalt plant	Operations started Jan, 50[7]

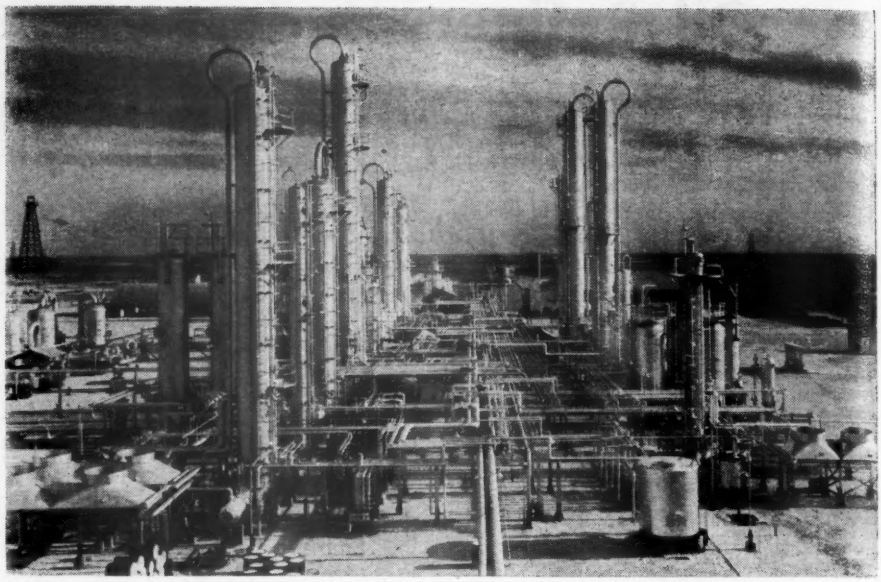
[1] Including distance and direction from nearest city or field.
[2] Complete skimming, skim-crk., lube, wax, asphalt.
[3] Operates in summer months only.
[4] Operating at 4,000 bbl a day.
[5] Will operate at 6,000 bbl a day.
[6] Will operate at 3,000 bbl a day.
[7] Operating at 1,000 bbl a day.

NEWS

Leduc Gas Plant Opened

Opening of the 24,000,000 cu ft gas conservation plant of Imperial Oil Ltd. in the field of that name in Alberta was celebrated May 12, with the Hon. N. E. Tanner, Albertan minister of lands and mines officiating. This plant was begun in June, 1949, built by C. F. Braun and Company of Alhambra, California, and plant and gathering system cost about $5,500,000. The plant currently is processing only about 17,000,000 cu ft of gas, but when production requires it will handle the maximum throughput.

The plant will produce natural gasoline and liquefied petroleum gases, mostly propane, which will increase importantly the amounts of that product available in western Canada. Butane also will be extracted as a fuel gas enricher, special solvent, or engine fuel. The plant's installation is in keeping with Imperial's gas conservation policy, says M. L. Haider, vice president of Imperial. It will continue to be operated as a conservation measure, even though under present conditions it "must be viewed initially as a deficit operation in the interest of conservation," Haider said.



Processing area of South Fullerton gasoline plant.

Stanolind's Gasoline Plant Holds Open House

The new South Fullerton gasoline plant operated by Stanolind Oil and Gas Company 17 miles west of Andrews, Texas, was inspected by invitation to the public recently. The plant is operated by Stanolind for 15 company owners interested in it and the field served by it.

The plant was designed to handle a total of 55,000,000 cu ft of raw gas daily when gas production in the area is at a maximum. Compressor capacity installed at present is 38,000,000 cu ft, from which plant recovers 80,000 gal of propane, 50,000 gal butane, and 50,000 gal of natural gasoline daily. Stripped gas is sold to a pipe line company for general distribution. The serious water problem for the plant is solved by pumping water from wells several miles away, the water being recirculated repeatedly, and make-up water being in relatively small amount.

Owners of the plant are: Stanolind, Mid-Continent Petroleum Corporation, Texas Pacific Coal and Oil Company, Superior Oil Company, Gulf Oil Corporation, The Texas Company, Anderson-Prichard Oil Corporation, Elizabeth Frankel, British-American Oil Company, Bay Petroleum Corporation, Pearl Frankel, Champlin Refining Company, Paul F. Barnhart, and Donald and Harding Frankel.

U. S. Patents Available For Foreign Filing

One-hundred one more U. S. government-owned patent applications have been made available for foreign filing, the Office of Technical Service has announced. This is the seventh group of patent applications to be released. Purpose of these lists is to give American manufacturers a chance to contribute funds for the filing, in the government's name.

Patents so secured will be licensed to American firms on a royalty-free and non-exclusive basis. Price of the list on Fuels and Lubricants, FP VII, is $2; for list FP VI, $1.40, obtainable from the Office of Technical Services, Room 1325, Commerce Building, Washington, D. C.

Columbia Fellowship Set Up

The Socony-Vacuum Oil Company, Inc., has awarded $2000 to Columbia University, New York, for establishment of a fellowship in surface chemistry and physics during the academic year beginning next September. It will be administered under the direction of Professor M. D. Hassialis, associate professor of mineral engineering.

Preu Declares Need for Aromatic Hydrocarbons

A growing need for aromatic hydrocarbons in the production of higher octane gasoline has been described by Fred Preu, assistant manager of Shell Oil Company's special products department. Preu spoke at an American Coke and Chemicals Institute meeting held at the Westchester Country Club, Rye, New York.

"To improve present-day high octane gasolines refineries are constantly seeking better methods to obtain the maximum percentage of aromatic hydrocarbons from each barrel of crude oil," Preu said. "The trend is definitely toward aromatics, even though they are expensive to make."

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Netherlands Refinery Officially Opened at Pernis

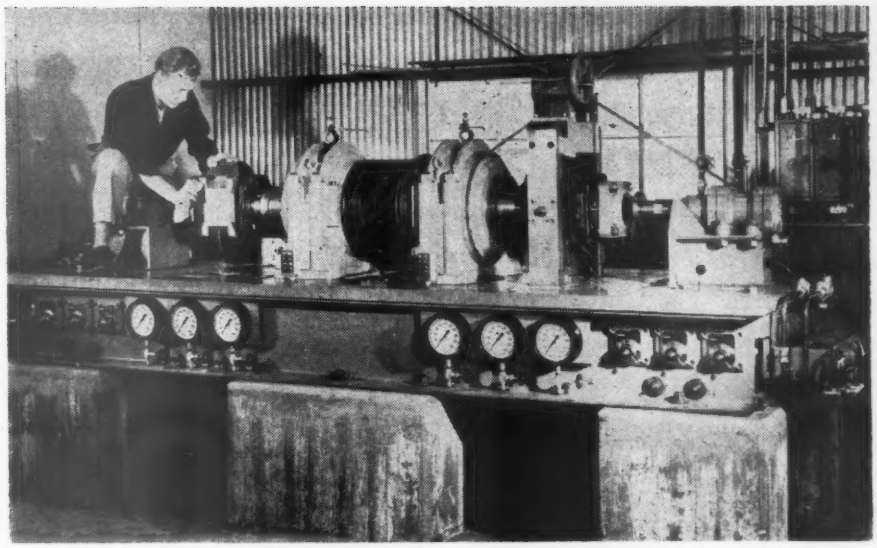
A new refinery has been officially opened at Pernis, eight miles from Rotterdam, Netherlands. The Caltex-Bahrein group of companies designed and began the construction of this plant. Although Netherlanders frequently refer to the project as "the little Marshall Plan," no ECA funds were employed.

Initially the plant will employ 500 workers, about 90 per cent of whom are Netherlanders. In an attractive suburb the 256 houses for the workers have been completed and plans are underway for the construction of a number of larger houses for the supervisory personnel.

The plant will operate on American controlled crude oil from the Persian Gulf. To provide the crude oil for the operation of the refinery, Caltex must arrange for a large ocean-going tanker to arrive at the Port of Rotterdam every fourth day.

Gasoline, power kerosine, automotive kerosine, automotive and industrial diesel oils, and fuel oils will be manufactured and supplied to the economic distribution areas of Holland, Belgium, Luxembourg and perhaps the parts of Germany and Switzerland that can be reached through the Rhine.

At a cost of $18,000,000 the refinery was built literally from the ground up, because even the land on which it now stands did not exist. This refinery is the most modern in all of Europe and covers 104 acres of built up land supported on 2400 reinforced concrete piers. These are 14-in. square and vary from 35 to 100 ft in length.



Texaco railroad bearing test machine.

New Unit for Making Catalyst to Open

A new supplier of spray-dried microspheroidal cracking catalyst will soon appear in the oil refinery field, H. A. Kern, president, National Aluminate Corporation, Chicago, Illinois, has announced.

An expansion program for the company's catalyst division plant, Chicago, calls for the installation of complete equipment for producing microspheroidal catalyst by spray drying operations. The addition of this latest type equipment will virtually double the overall production capacity of the catalyst division.

Already underway, commercial scale production of the spray dried catalyst is anticipated by the latter part of this year.

Pernis refinery near Rotterdam, Netherlands.

Test Bearing Built

A railroad test bearing weighing 14,000 lb and capable of handling loads up to 50,000 lb has been constructed by The Texas Company research department laboratories at Beacon, New York, for investigations on the requirements for lubricants for this purpose. The apparatus will handle the bearings of all makers of railroad axle bearings; will simulate car speeds of up to 100 miles per hour, and will reproduce conditions of steady loads and shock loads, both vertical and thrust, experienced in railroad car operation. It is expected that this unit, the largest of its type Texaco has ever built, will show the way to increased operating speeds and comforts, as well as economies.

Vertical loads of 50,000 lb may be applied to the two test bearings, at each end of the machine, and 15,000 axial loads can also be applied. Loads are applied hydraulically and each bearing can be loaded independently of the other. The machine is built on concrete piers six feet deep into the ground. Instrumentation provided will measure bearing friction, speed, load, and temperatures during tests. It is built in accordance with American Association of Railroads axle design standards.

Product Used in Paint

S/V Foamrex S, manufactured by the Socony-Vacuum Oil Company, Inc., with a petroleum product as its base, is being utilized by the paint industry as a defoamant in water-base paints, according to Socony-Vacuum. Officials said S/V Foamrex S permits use of emulsion equipment at full capacity and overcomes a difficulty in the packaging operation.

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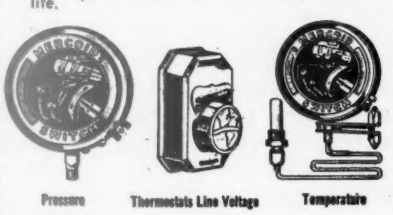

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Effect of Fuel on Plastics

Research at the U. S. Bureau of Standards to show the effect on laminated plastics of repeated immersion in hydrocarbon liquids and drying between immersions is being carried out by the National Advisory Committee for Aeronautics under the direction of W. A. Crouse, Margie Carickhoff, and Margaret A. Fisher. The test consists of 10 alternate 24-hour periods of immersion and of drying, with determination of changes in weight, dimensions and flexural properties. Fuels used include toluene, heptane, and representative aircraft fuel.

Plan Oil Shale Conference

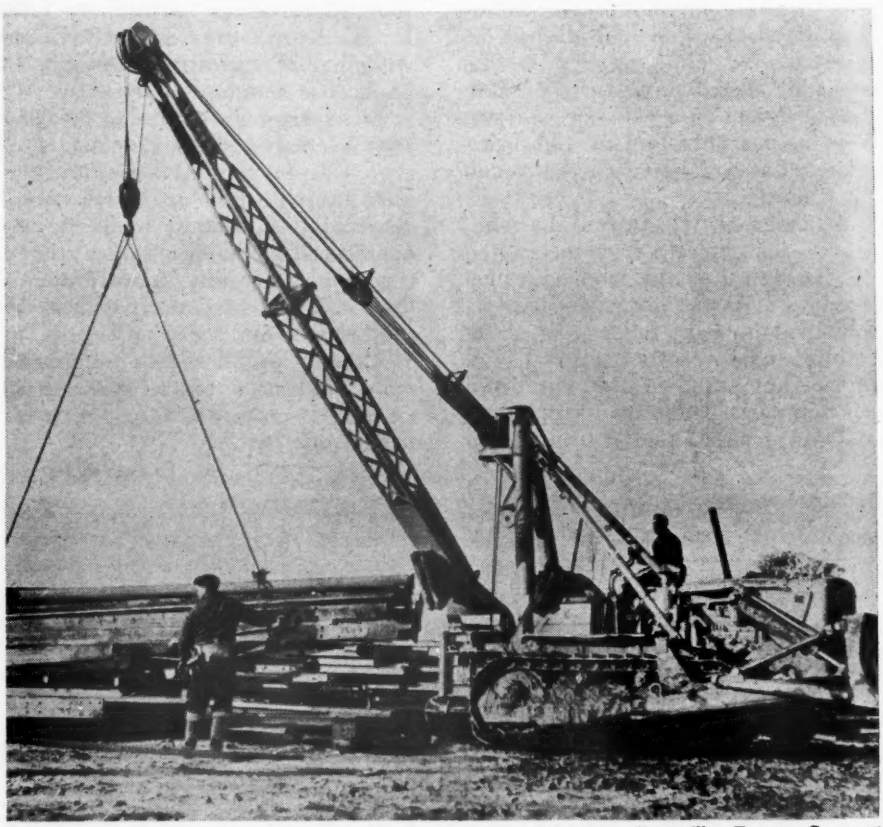
Arrangements for the Second Oil Shale and Cannel Coal Conference, which the Institute of Petroleum is holding in Glasgow during the period July 3-7, 1950, are making progress.

Details of the program show that in the technical sessions nearly 50 papers will be presented. Every phase in the industry will be dealt with authoritatively by technicians and much valuable discussion should result.

The Bureau of Mines of the U. S. Department of the Interior, is discussing the work on its experimental oil shale mine in Colorado, and information will be given concerning the Ljungstrom method of treating oil shale in situ. Current practice in Australia, South Africa, France, etc., will also be described.

Propose Reclaim Oil Tax

Congress should levy a six-cent tax on reclaimed lubricating oil, to equalize oil taxes, D. C. O'Hara, attorney for Pennsylvania Grade Crude Oil Association in Washington, told the directors of that body in Oil City recently. Reclaimed oils are exempt from taxation, and are sold in competition with new lubricating oil on which six cents tax is levied. Oil men should make known their views to the House Ways and Means Committee, which is considering new ways for raising revenue, O'Hara stated.



Courtesy Caterpillar Tractor Company

Tractor moves steel beams at Fawley refinery site.

Work Underway on Fawley Refinery, England

The building of the new $100,000,000 Anglo-American oil refinery is now well underway at Fawley, England. It will be the largest refinery in Europe and will turn Middle East crude oil into fuel for use in England and on the continent.

When the project is finished in 1951 over 5,000,000 tons of crude oil will be processed yearly from which a daily output of 1,000,000 gal of sterling petrol is expected.

The labor force working on the job runs into the thousands and over 170 bulldozers, trucks, and cranes are being employed.

Sulfur May Be Produced From Hydrogen Sulfide

West Texas oil men someday may be turning an old nuisance, hydrogen sulfide, into hard cash. The compound is available in commercial quantities in the 30,000 square-mile Permian Basin of West Texas and New Mexico, a University of Texas researcher reports.

W. A. Cunningham, chemical engineering professor, has completed a study of the two-state area's hydrogen sulfide reserves and current output of the substance as a petroleum byproduct.

Sulfur can be produced economically from hydrogen sulfide by adding facilities at the gasoline plants. Only transportation costs for shipping Permian sulfur to areas where it is used will keep it from competing with other supply sources. "There is a possibility that the Basin's hydrogen sulfide may be converted into something of higher value than sulfur. If that happens, it will compensate for the higher transportation costs," Cunningham said.

French Chemists Tour Texas

As part of a three weeks' study tour of Texas, directed by the state university, eight of France's leading petro-chemists spent 10 days inspecting refineries and chemical plants in south Texas.

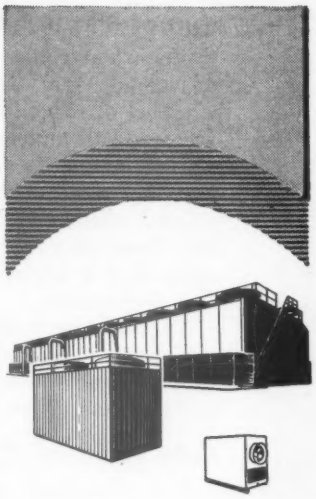
Units visited were: Humble Oil and Refining plant at Baytown, Dow Chemical Company plant at Freeport, Shell Oil Refinery and chemical plant at Deer Park, and Monsanto Chemical plant and Pan-American Oil Refinery at Texas City.

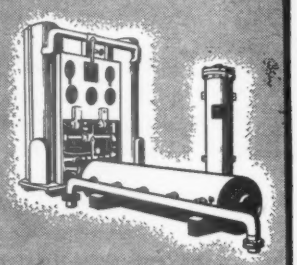
In the visiting group were: Andre Thira, chief chemical engineer of the French Ministry of Industry and Commerce; Rene Granier de Lilliac, Gustave Pellegrin, Jean Louis Bergeron, Edmond A. Bation, Robert Mougenot, Raymond Gay, and Robert Pierre Degain.

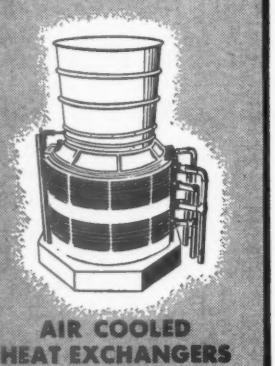
Cita Company Honored

The Cita Chemical Company, Bronx, New York, a junior achievement group sponsored by Socony-Vacuum Oil Company, Inc., has won an award for being "best in chemicals in the Greater New York area." The company makes and sells furniture polish under the brand name "Cita."

Under the program, junior and senior high school boys and girls learn American corporate business methods by forming their own companies engaging in various types of enterprises. They sell stock, elect officers, make and sell their products or services, and declare profits or loss, etc.


COOLING TOWERS


GAS EQUIPMENT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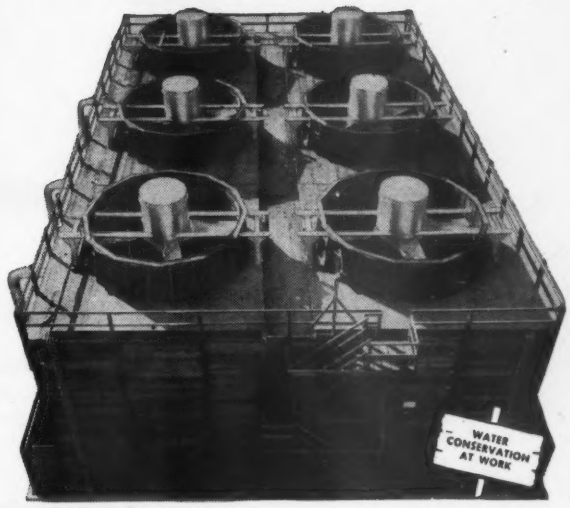

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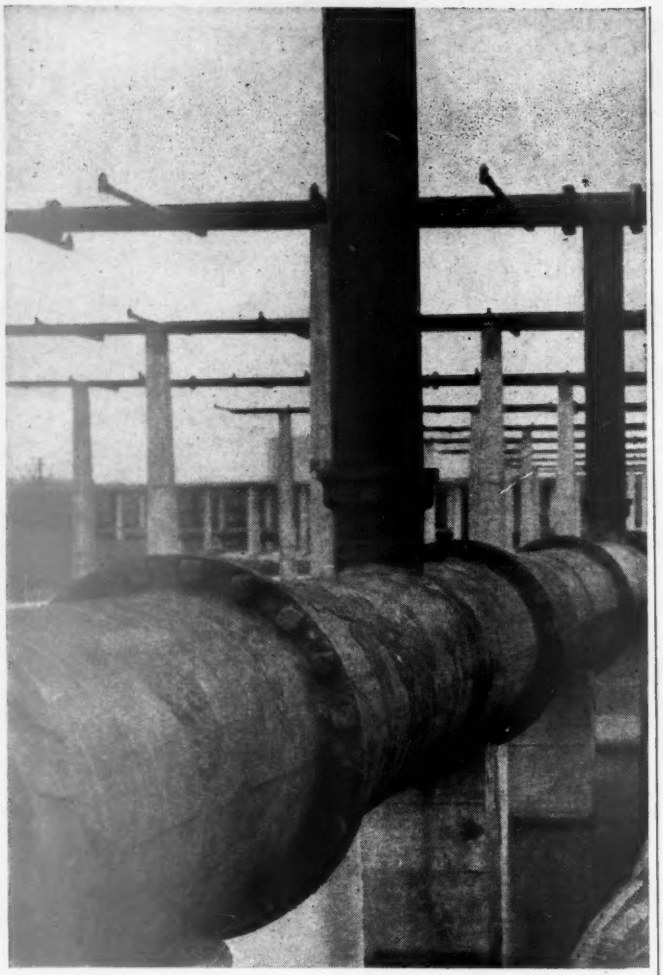

AN ECONOMY FACTOR
IN REFINERY OPERATION

Proved long life and stubborn resistance to corrosion make cast iron pipe a contributing factor in lowering plant maintenance per barrel of crude. Replacing shorter-lived pipe with cast iron pipe has demonstrated this in many refineries. Cost per term of service decreases. Interference with production, caused by frequent replacements, ceases to be a headache. Cast iron pipe works hand-in-glove with plant management to keep maintenance cost down in many refinery operations. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

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Rumor Plant Site Bought

Persistent rumor says that the Lubrizol Corporation of Cleveland, Ohio, has purchased a site on the Houston Ship Channel on which to erect, in the near future, a $500,000 factory. This unit will be used in the manufacture of certain of that company's oil additives now in wide use in the petroleum and allied industries. It will be situated in the vicinity of such plants as Shell Chemical Company, duPont, Rohm and Haas, Diamond Alkali, and several other plants operating in that region, one of the most active of the nation's chemical centers.

The new plant will be in close proximity to some of its raw materials and intermediate suppliers, as well as very short distances from several refining companies, large consumers of additives for fuels and lubricants.

Italy Refining Capacity Up

The Economic Cooperation Administration has announced that under an expansion program financed by a joint American-Italian company Italy will be able to reduce her imports of oil products by about $20,800,000 a year.

ECA also reported the signing of an industrial guaranty contract with Standard Oil (New Jersey) to almost treble present crude oil capacity at Leghorn refineries of the Italian company, Anic, and modernize operations at Anic's Bari refineries. Present daily crude capacity is 12,000 bbl at Bari and 7500 bbl at Leghorn.

A dollar saving of $4,200,000 to Italy has been estimated by ECA. About $16,000,000 crude oil imports will be required for the installation.

Process Heating Seminar

The first annual process heating seminar was held at the meeting hall, John Zink Company, 4401 South Peoria, Tulsa, Oklahoma, June 10, according to announcement by Robert D. Reed of the Zink Company. The seminar included four sessions of one hour each, with 15-min intermissions between sessions.

Subjects discussed were *Metallurgy for High Temperature-High Sulfur Process Conditions*, Francis Fahrenwald; *Performance of Thermal Poly Trans-Economizers*, J. H. Smith, Continental Oil Company; *Economics of Waste Heat Recovery*, L. D. Stewart, Mid-Continent Petroleum Corporation; *A New Approach to Design for Radiant Heat Transfer in Process Work*, Robert Reed, chief engineer, John Zink Company. A question and answer session brought the meeting to a close.

Refinery Workers Get Safety Awards

Production employees of the Northwest division and workers at the Billings, Montana refinery of The Carter Oil Company have been voted certificates for safety efficiency by the Joseph A. Holmes Safety Association, the U. S. Bureau of Mines announced recently.

The Billings refinery group, numbering more than 200 workers, was cited for operating from December, 1946 to January 1, 1950 without a lost time accident. The production employees of Carter in the Northwest were cited for having no lost time accident for five years from January, 1945 to January, 1950.

Houston Offices Set Up

Refinery Maintenance Company, Inc., of Compton, California, has established permanent offices at 4604 South Main Street, Houston, Texas, President F. J. Buckner announces, in order to bring the company into closer reach with its customers in the midwest and southwest. The new office is now processing the procurement of materials, and the engineering for the large gasoline plant, which is being built for Shell interests at Elk City, Oklahoma.

—PERSONALS—

Dr. Frederick D. Rossini, chief of the thermochemistry and hydrocarbons section of the National Bureau of Standards, has been named to receive the Department of Commerce Exceptional Service Award for his outstanding contribution to the field of hydrocarbon research.

Dr. Rossini is internationally known as an authority in thermochemistry and the physical chemistry of hydrocarbons. He has contributed extensively to scientific journals in the fields of thermochemistry, chemical thermodynamics, hydrocarbons, purification of hydrocarbons, and preparation of standard samples of hydrocarbons.

He received a bachelor's degree in chemical engineering and a master's in science in 1926 from the Carnegie Institute of Technology, and a doctorate in physical chemistry from the University of California. He joined the staff of the National Bureau of Standards in 1928 as a physical chemist in the thermochemical laboratory and became chief of the section of thermochemistry and hydrocarbons in 1936.

E. B. Palmer has been appointed manager of the Los Angeles, California, refinery by Union Oil Company of California. Palmer succeeds K. E. Kingman.

Glenn Kinnick, superintendent of the Phillipsburg, Kansas, refinery of Co-operative Refining Association, has been named manager of the Coffeyville, Kansas, refinery. Kinnick, who has been at the Phillipsburg refinery since 1939, succeeds **Louis C. Brown.**

Peter A. Anderson, Utilities Distributors, Inc., Portland, Maine, has been elected president of the Liquefied Petroleum Gas Association. He succeeds **Si G. Darling,** Pratt, Kansas.

Other officers elected at the annual meeting in Chicago, Illinois are: **William S. Lander,** Rulane, Inc., Charlotte, North Carolina, first vice president; **F. N. Mabee,** Colorado Natural Gas and Fuel Company, Denver, second vice president; **Arthur Kreutzer,** Chicago, Illinois, secretary, and **Walter Muller,** Dri-Gas Corporation, Chicago, treasurer.

Sectional chairmen named at the meeting include: **Harris Helmer,** Badger Gas Products, Plattville, Wisconsin, marketing; **Kevin J. Fordenbrugen,** Minnesota Valley Natural Gas Company, St. Peter, Minnesota, utilities; **Joseph Ketner,** Delta Tank Manufacturing Company, Baton Rouge, Louisiana, equipment; **H. W. Rigterink,** Sun Oil Company, production, and **Paul Thompson,** Standard Oil Company (New Jersey), international.

Robert L. Aycock, New Orleans, was elected vice president, and **R. T. Colquette,** El Dorado, Arkansas, was named a director, of the Pan-Am Southern Corporation. Colquette, who is general manager of the El Dorado refinery, was named to the board at the annual meeting of stockholders, in Shreveport, on April 25.

H. S. Read, vice-president and chairman of the Corporation's marketing committee was also named chairman of the supply and transportation committee.

Directors elected were B. K. Brown, president; Aycock, Read, Roy J. Diwoky, M. C. Hoffman, T. W. Hughes, vice presidents; and Colquette, J. B. Hamblen, D. P. Hamilton, and F. R. Lutenbacher.

Additional officers re-elected include **A. L. Reid,** treasurer; **A. J. Ganier,** comptroller; **T. E. Beaird,** secretary; and **G. P. Brown** and **P. J. Schowalter,** assistant secretaries.

John Wolfe, Gulf Oil Corporation, has been transferred from Port Arthur, Texas to Sweetwater. He will be chemical engineer in the company's treating plant in Sweetwater.

W. G. Copeland has been appointed superintendent of the Eagle Point Works of The Texas Company, in New Jersey. He replaces **A. M. Martin,** who is retiring from active company service.

Copeland was graduated from Rice Institute, Houston, in 1927, as a chemical engineer. He was first employed by The Texas Company in 1926 as a helper in the laboratory at the company's Port Arthur, Texas, refinery and, after his graduation from Rice, as a chemist there. He was appointed superintendent of the company's refinery at Sunburst, Montana, in 1943. During the construction of Eagle Point refinery Copeland was transferred to South Jersey and was appointed assistant superintendent.

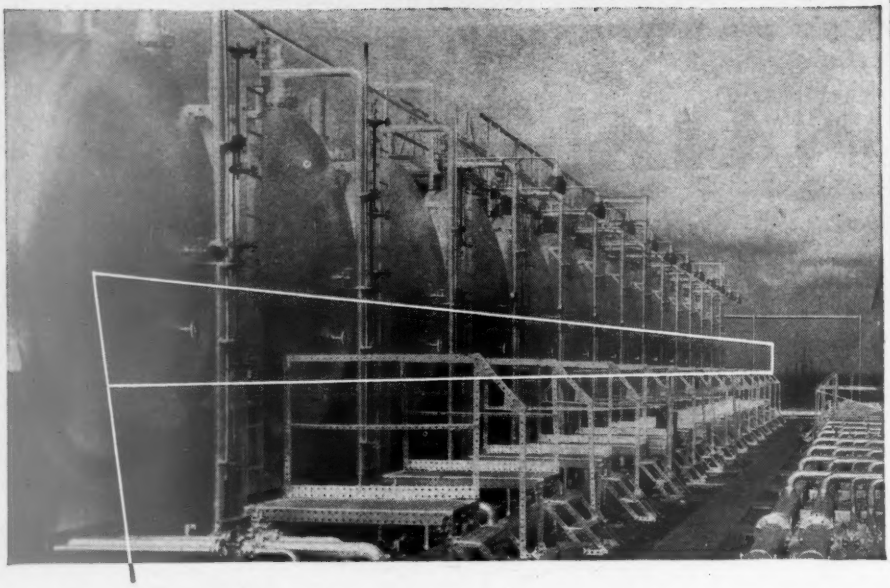
Dr. Wayne E. Kuhn

Dr. Wayne E. Kuhn, manager of the technical and research division of The Texas Company, has been awarded the second Honor Scroll of the New York American Institute of Chemists. The citation to Dr. Kuhn reads, "In recognition of his tireless efforts in advancing the chemical profession, by writing and lecturing, by discussion and by effective organization. His leadership has also contributed greatly to technical advances in the field of petroleum chemistry."

Dr. Kuhn's professional career has been largely identified with The Texas Company. He began work with The Texas Company in 1929 as a chemist. In 1938 he became manager, technical and research division, in charge of all technical and research work for the refining division.

In 1949 he was chairman of the petroleum division of The American Chemical Society. He is a member of The American Rocket Society, American Society of Testing Materials, American Forestry Association, Army Ordnance Association, Society of Automotive Engineers, Chemical Warfare Association, Institute of Aeronautical Sciences, National Farm Chemurgic Council, The American Institute of Physics, and Fellow of the American Institute of Chemists.

He obtained a BA degree from Reed College, Portland, Oregon, and a PhD from Cornell University.



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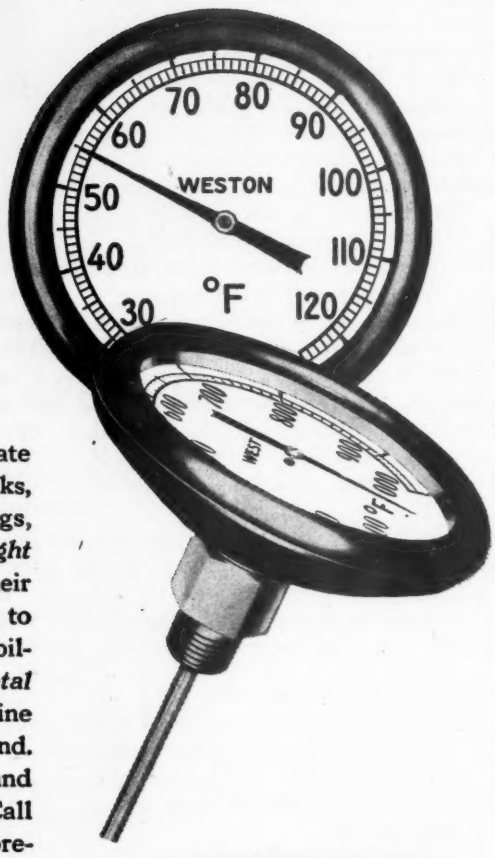

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▸ **Carlos C. Blount,** former assistant chief engineer, has been advanced to the position of refinery safety engineer, for Deep Rock Oil Corporation's Cushing, Oklahoma, refinery. This new assignment is in line with an expanded company policy of establishing safer methods, equipment and operations throughout the refinery.

Jon W. Beam, former supervisor of instruments, has been named development and instrument engineer.

Robert A. Forsman, former refinery maintenance supervisor, has been appointed assistant chief engineer to fill the position vacated by Blount.

L. W. Vickery, new manager of engineering department of Continental Oil Company.

▸ **Dr. Harold R. Snow** has been elected vice president of Pan American Refining Corporation, and **Rodney M. Nash,** a member of the board of directors of the Refining Corporation, Pan American Gas Company, and Mexican Petroleum Corporation of Georgia.

Snow will continue as plant manager of the Pan American refinery in Texas City, a position he has held since September, 1947. He became a member of the board of directors in 1948.

Nash, who is general counsel of Pan American Petroleum and Transport Company, succeeds **P. J. Sweeny,** who recently was elected chairman of the board of directors of Pan American Pipe Line Company.

▸ **Gene Rankin** has been appointed sales representative of Synthane Corporation, Oaks, Pennsylvania, in the Kansas City, Missouri area. He succeeds Ernest Bernard, who died recently after 18 years with the company.

Rankin, Bernard's assistant since 1946, will direct sales in Nebraska, Kansas, Colorado, western Missouri, and southwestern Iowa. The Synthane Corporation is laminator and frabicator of thermosetting plastics for the petroleum and other industries.

Is the Gas Age Just Beginning?

RAPID expansion of the natural gas industry during the last decade, and particularly within the last few years, might lead to the supposition that the peak has been passed and a leveling-off process is in the offing. The truth of the matter, however, is that the industry quite obviously is entering an even more golden era, an era that has led some to assert that the "gas age" is just beginning.

What are the supporting facts for such a belief?

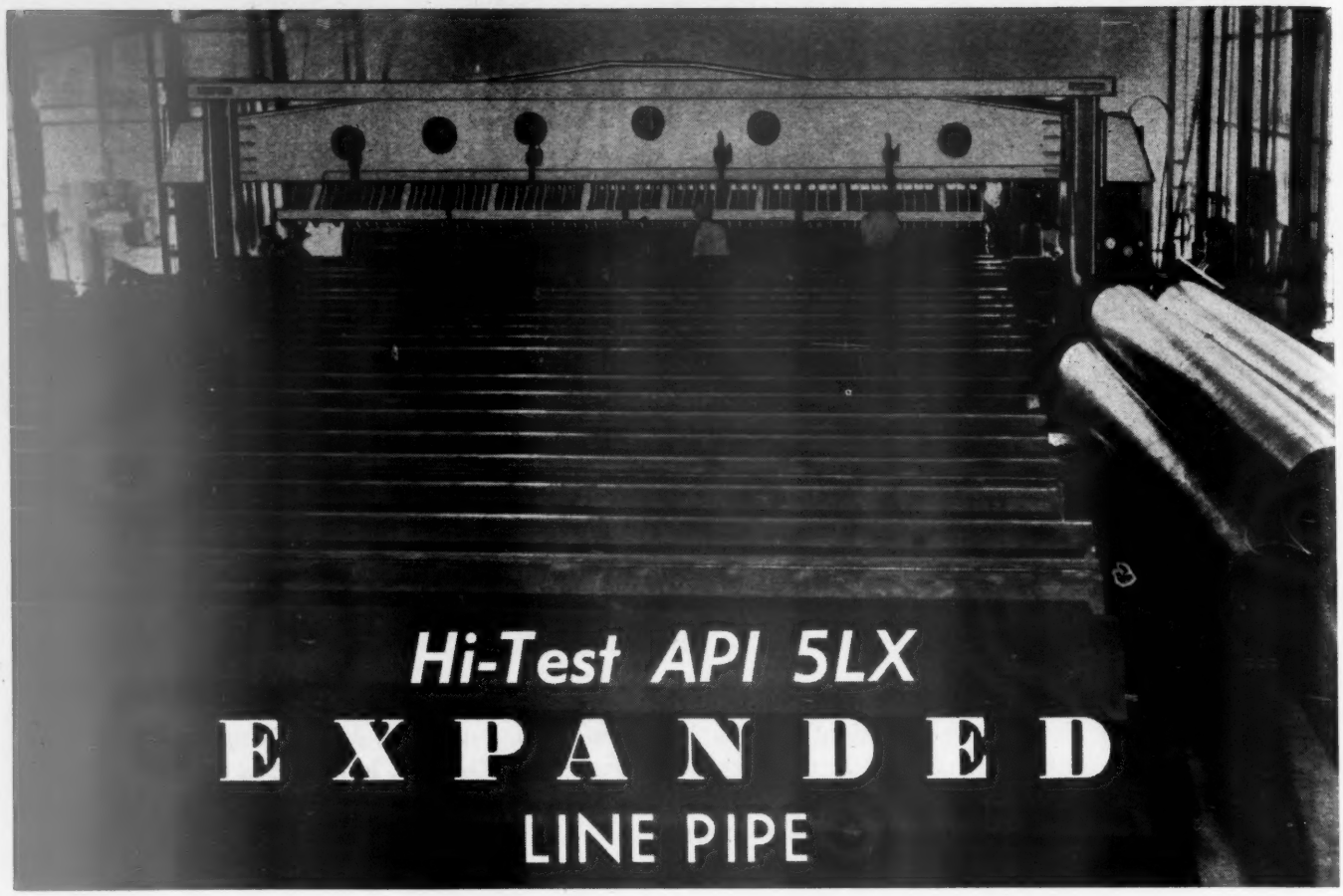
Hugh H. Cuthrell, president of the American Gas Association, predicts that the sale of gas will double or triple within the next decade. Other prominent gas men say sales will double within the next five years. One government agency, after making a study, has stated that natural gas sales will increase another 50 per cent by 1952.

D. A. Hulcy, chairman of the Natural Gas Division of the American Gas Association, points out that the gas industry is today supplying 19.5 per cent of the nation's fuel as compared with 11 per cent in 1941. Since 1942, and up to February 1, 1950 the Federal Power Commission has approved certificates covering construction of 30,138 miles of line, having a daily rated capacity of 10.6 billion cu ft, or 3.4 trillion cu ft a year. There are now before the Commission applications for about 13,700 miles of line, although some of these duplicate supply to certain markets, and thus certificates probably will not be granted for the total amount. Mr. Hulcy summarizes: "It seems reasonable to estimate that the effect of the additional feasible lines on the production of natural gas in this country would be an annual increase of about 1 trillion cu ft."

With such a tremendous demand for gas to heat homes, for use in industrial plants, and in the manufacture of chemicals, is there danger of the supply being depleted? This is a logical question and one that is answered by the recent report to the American Gas Association in Tulsa by N. C. McGowen, chairman of the AGA Committee on Natural Gas Reserves. Production during 1949 was 6.2 trillion cu ft, he pointed out. During the year, however, 4.6 trillion cu ft were added to total reserves through discoveries of new pools and 8.1 trillion cu ft through extension of known pools and other developments. The net result was an increase in reserves of 6.5 trillion cu ft, which now stands at 180.4 trillion cu ft.

On such a basis the industry does not seem to be in danger of "running out" of gas for some time to come.

J. H. Love



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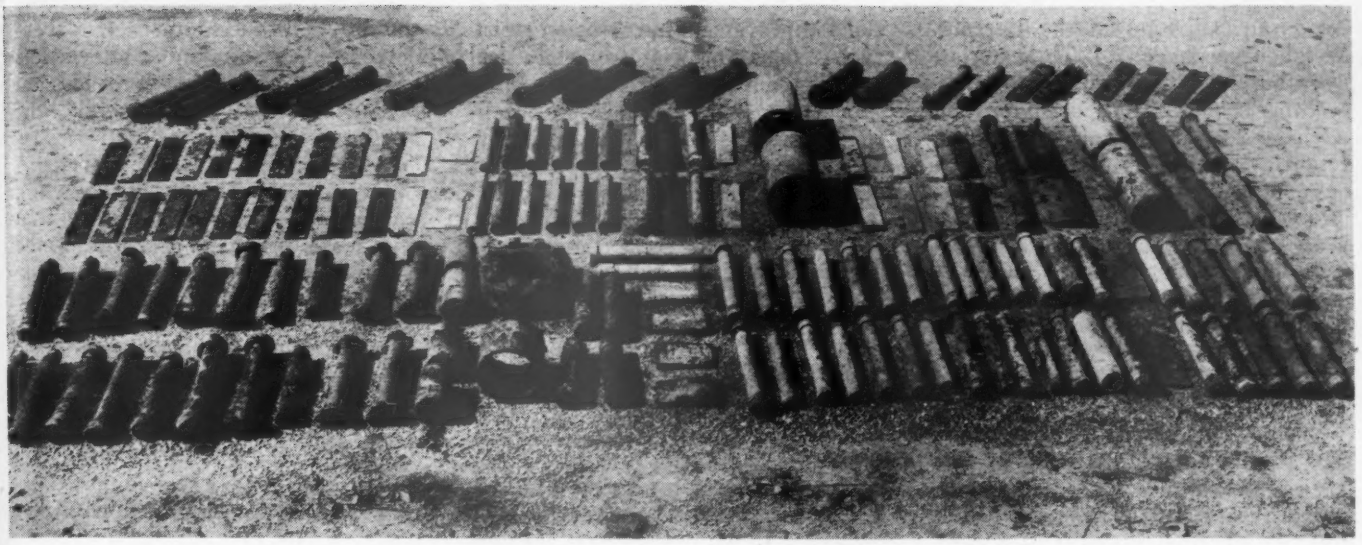


FIG. 1. Specimens removed in 1946 from the test site in Hagerstown loam at Loch Raven, Maryland.

Corrosion of Materials of Construction Underground

National Bureau of Standards reports on tests in which numerous metals and alloys were exposed in soils of different physical and chemical properties to determine those most effective for use underground.

I. A. DENISON

PART 1

Corrosion data are presented on low-alloy irons and steels, high-alloy steels, copper, copper-zinc alloys, lead, and zinc exposed to soils for periods up to 14 years. The 15 soils to which the materials were exposed range from well-aerated soils deficient in soluble salts to poorly aerated soils containing high concentrations of soluble salts. The magnitude and progress of corrosion are interpreted in relation to the properties of the soils at the test sites. A comparison is made of the corrosion of iron, copper, lead, and zinc in several typical soil environments.

THE use of coatings of bituminous materials, supplemented if necessary by cathodic protection, is standard practice for the protection of underground transmission pipe lines against corrosion. For other types of installations, however, such as distribution systems of small-diameter pipe, cable sheath, grounding systems, piling, etc., corrosion may be more effectively combatted by the use of metals that are either inherently more resistant to corrosion than are plain iron and steel or which sacrificially protect these metals from corrosion. With the object of obtaining information that would lead to more effective use of metals in underground construction, the Underground Corrosion Section of the National Bureau of Standards inaugurated in 1932 a field investigation of the corrosion of a wide variety of metals and alloys in soils of different chemical and physical properties. Progress reports giving the results of the exposure tests have been published during the course of the investigation; but generalizations concerning the corrodibility of the metals under study have been deferred until all the specimens of a given class of materials shall have been removed from the test sites and the extent of corrosion evaluated. As complete data have now been obtained for certain classes of materials, and definite trends have been indicated by incomplete data for others[1, 2], it is possible at this time to bring to the attention of the pipe line industry the results of the investigation that are of practical importance.

The investigation of the behavior in soils of materials normally resistant to corrosion was conducted in the same manner as the original soil cor-

[1]References at close of Part 2.

EXCLUSIVE

The Author

I. A. Denison is Chief, Underground Corrosion, Section Division of Metallurgy, National Bureau of Standards, Washington, D. C. He received a BS in 1920, and an MS in 1921, both from the University of Illinois, and in 1929 a PhD degree from George Washington University. He was soil technologist with the Bureau of Chemistry and Soils, U. S. Department of Agriculture from 1922 to 1929. He has been a member of the staff of the National Bureau of Standards since 1929 and was appointed to his present position in 1947.

rosion investigation of the Bureau[8]. Weighed specimens of the materials were buried in 15 locations throughout the United States, each location having been carefully selected to represent, so far as possible, some well-defined environmental condition. At intervals, usually of two years, specimens of each material were removed from the test sites for study. In Fig. 1 is shown the set of specimens that was removed from the test site near Loch Raven, Maryland, in 1946.

Ferrous Metals and Alloys

Effect of composition. The resistance to atmospheric corrosion shown by some of the modern low-alloy, high-strength irons and steels is due to the presence of small amounts of one or more of the elements copper, nickel, chromium, molybdenum and/or other minor alloying constituents. As the corrosion resistance of these alloys depends on the formation of a continuous adherent layer of corrosion products, it seemed reasonable to expect some improvement in corrosion resistance of the alloy steels over plain steel in soils readily permeable to the oxygen of the atmosphere. In soils deficient in aeration and approaching the condition of submerged corrosion, less benefit from the presence of the alloying elements would be anticipated.

In order to observe the general effect of the various alloying constituents on the corrosion of steels in soils, the weight losses and maximum depth of pits on pipe specimens of each material in all of the soils were averaged for each period of exposure and plotted against the duration of exposure. These data are shown graphically in Fig. 2 for an open-hearth iron containing 0.52 per cent of copper and 0.15 per cent of molybdenum (material H); a 2.5 per cent nickel—1 per cent copper steel (D); and for a 5 per cent chromium steel (P); and for comparison, hand- and mechanically-puddled wrought iron (A and B) and low carbon steel (N) as reference materials. Because the soils at the different test sites differ widely in corrosiveness, the standard deviations of the mean values for weight loss and pitting are large. Consequently, differences between the weight losses for low carbon steel N and materials A, B, and P, are shown by statistical analysis to be more apparent than real. However, the copper-nickel steel D is shown to be somewhat more corrosion-resistant than low carbon steel N. On the other hand, the addition of copper without nickel (material H) apparently contributed nothing to the corrosion resistance of the steel. The 5 per cent chromium steel P showed a decided tendency toward pitting, but this is probably not typical of 4-6 per cent chromium steels, as will be shown later.

The beneficial effect of chromium on the basis of weight loss is indicated in Fig. 3 by the data for materials K, D, E, and H, which contain from 2 to nearly 6 per cent of chromium. The added effect of molybdenum in reducing the weight loss of chromium steels

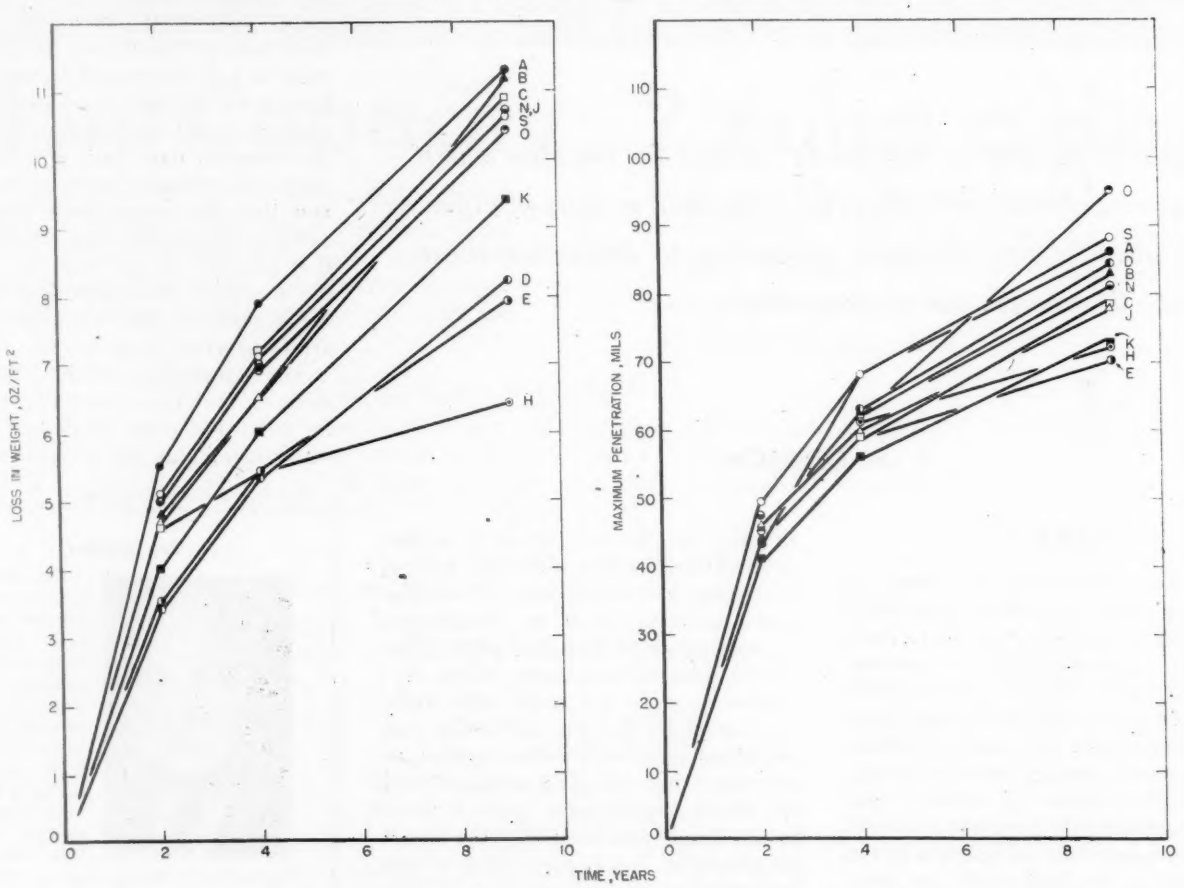


FIG. 2. Average loss in weight- and maximum penetration-time curves of wrought pipe specimens in 13 soils.

N low carbon steel.
A wrought iron—hand puddled.
B wrought iron—mechanically puddled.
H open-hearth iron—0.52% Cu, 0.15% Mo.
D steel—2.47% Ni, 1.01% Cu.
P steel—5.05% Cr.

is indicated by the curves for materials E and H, both of which contain approximately 0.5 per cent of molybdenum in addition to 4.67 and 5.76 per cent of chromium, respectively.

The tendency of chromium to reduce weight loss apparently does not extend to preventing the development of deep pits. Thus the 5 per cent chromium steel D, which lost less weight than the materials that contained smaller amounts of chromium, showed no improvement with respect to pitting (Fig. 3). On the other hand, the effect of molybdenum in reducing the depth of the deepest pits as well as weight loss is indicated by the fact that the materials containing approximately 0.5 per cent of molybdenum, E, H, and K, also show relatively low values for maximum penetration. It is noteworthy that the average depth of the deepest pits on material K, which contained only 2 per cent of chromium, was no greater than the corresponding values for materials E and H, both of which contained from two to three times as much chromium.

Because several of the materials containing chromium contained molybdenum as well, it is somewhat difficult to determine the specific role of chromium in these steels. Certainly, the data shown in Fig. 3 do not confirm the harmful effect suggested by the data for the 5 per cent chromium steel P (Fig. 2). It was thought that this acceleration of pitting might have been due to galvanic action set up between the ferrite and chromium carbides precipitated along the grain boundaries, but microscopical examination showed that the microstructure of material P was that of a normal 4-6 per cent chromium steel.

The results of the tests of steels B (Fig. 3) and D (Fig. 2), each containing 2 per cent of nickel and 1 per cent of copper, are conflicting. Material D (Fig. 2) was seen to be definitely superior to plain steel with respect to weight loss and to pitting, whereas the data for material B (Fig. 3), having the same nominal composition, show no significant benefit from its content of nickel and copper. A probable explanation for this difference in behavior is the acceleration of corrosion from the presence of

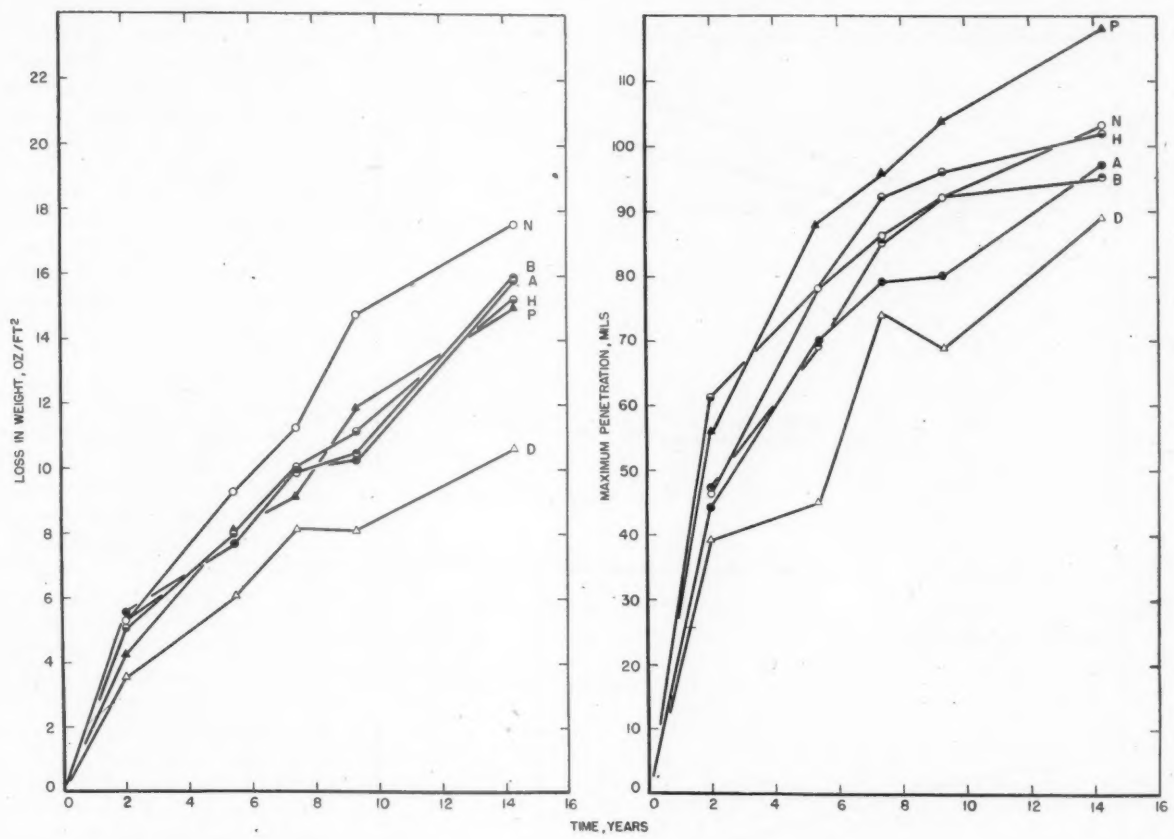


FIG. 3. Average loss in weight- and maximum penetration-time curves of wrought plate specimens in 14 soils.

S plain carbon steel.
A open-hearth steel.
O open-hearth iron—0.45% Cu, 0.07% Mo.
N open-hearth iron—0.54% Cu, 0.13% Mo.
J steel—0.95% Cu, 0.52% Ni.
B steel—1.96% Ni, 1.01% Cu.
C Cr-Si-Cu-P steel—1.02% Cr, 0.42% Cu.
K steel—2.01% Cr, 0.57% Mo.
D steel—5.02% Cr.
E steel—4.67% Cr, 0.51% Mo.
H steel—5.76% Cr, 0.43% Mo.

mill scale on material B, which unlike D, had not been pickled.

Comparison of the average corrosion resistance of the different materials in all of the soils is no indication of the behavior of these materials in any one soil or environment. Consequently, superior corrosion resistance of a material in any one environment might be obscured by inferior resistance in another. In order to compare the corrosion of the materials under specific environmental conditions, the soils at the test sites were classified according to the nature of the environment. The soils were first placed in two groups according to whether they were organic or inorganic, then into sub-groups according to their oxidizing or reducing nature, and finally according to acidity or alkalinity. The corrosion data for all the soils in each environmental group were calculated on a relative basis for each period of exposure, the standard of reference (plain steel) being taken as 100 per cent. For each material, the averages of these percentages for all periods and for all soils in the same environmental group were then calculated. In all environments the chromium steels identified in Fig. 3 lost less weight than the reference steel A, and in all environments except the organic-reducing, the maximum pits were shallower on the chromium steels. As has been previously noted, however, the specific effect of chromium on corrosion is somewhat difficult to evaluate because some of the chromium steels also contain molybdenum.

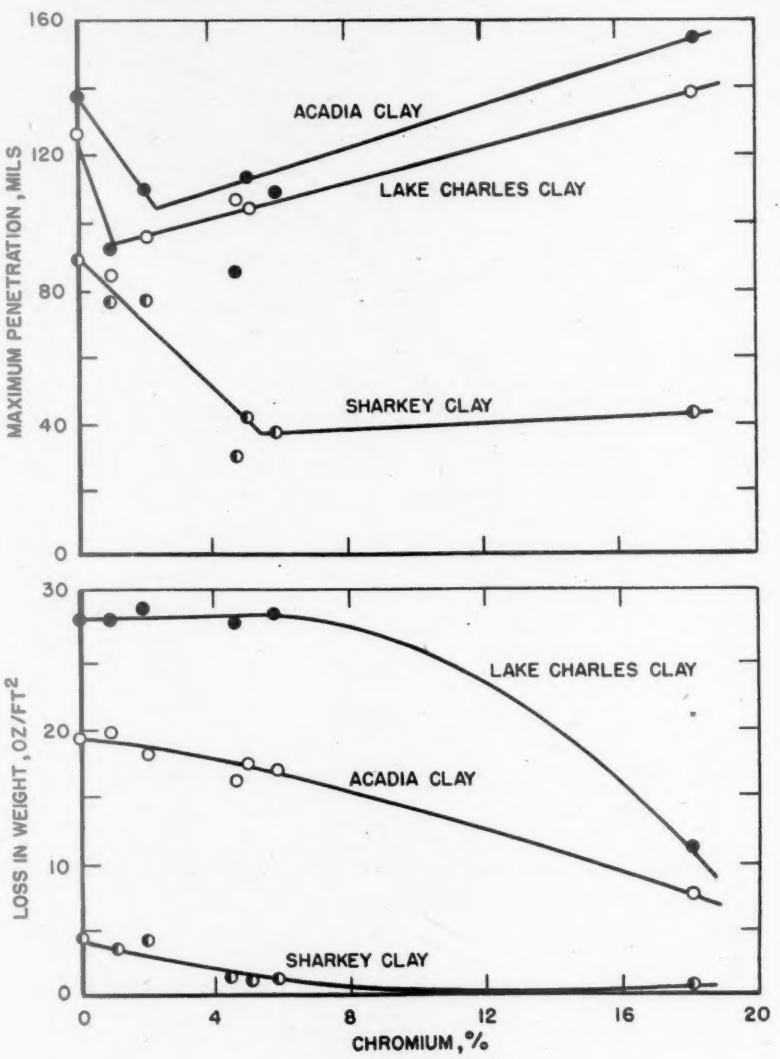


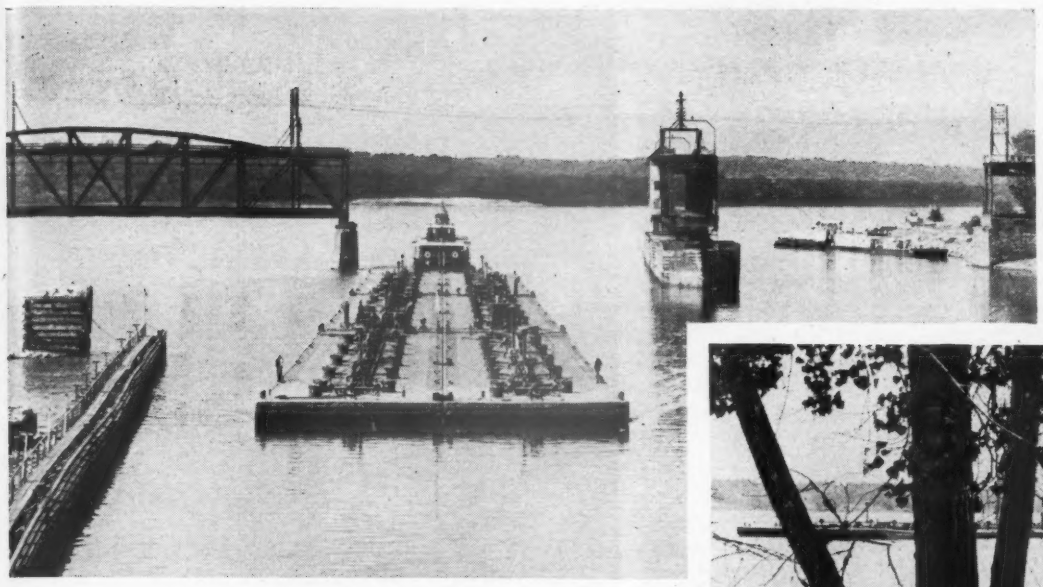
FIG. 4. Effect of chromium content on loss in weight and pitting of steels in 3 poorly aerated soils—exposure 9 years.

The effect of addition of chromium up to 18 per cent on the corrosion of steel in three poorly aerated soils is illustrated in Fig. 4. These curves indicate that the advantage gained in reduction of pitting by the addition of chromium may be lost if it exceeds a certain optimum amount. In fact, the pit depth-time curves for Acadia clay and for Lake Charles clay indicate that steels containing 18 per cent chromium develop deeper pits in poorly aerated soils than do steels containing from 2 to 6 per cent of chromium.

If chromium and nickel are added to steels in amounts somewhat greater than are present in the conventional 18 and 8 steel, corrosion apparently is prevented entirely. No appreciable corrosion has been detected in steels containing the higher chromium and nickel contents during exposure for 14 years to soils severely corrosive to ordinary iron and steel. In spite of this extraordinary resistance to corrosion, application of these results for predicting the life of actual installations should be made with great care because nothing is known at present concerning the manner in which the corrosion of high chromium-nickel steels changes with area exposed. For example, although an incipient pit may not develop on a small test specimen under a given condition, a large installation might encounter widely different environmental conditions over its surface, which might result in severe local pitting.

The effect of composition on the corrosion of irons and steels underground may be summarized by stating that nickel, chromium, and molybdenum generally tend to reduce the corrosion of low-alloy irons and steels in soils. In organic-reducing soils, however, additions of chromium up to 4-6 per cent appear to accelerate corrosion slightly. Copper alone in steels has no effect on their resistance to underground corrosion. The fact that only relatively slight improvement is shown by low-alloy steels to corrosion in soils, as compared with that in the atmosphere, suggests that soil conditions generally do not favor the deposition of continuous, adherent protective layers that are commonly encountered in atmospheric corrosion. Small samples of stainless steels containing chromium and nickel in concentrations somewhat greater than the conventional 18 and 8 types were not corroded in soils, but this may not be a safe criterion for predicting the behavior of large installations of this material. * * *

The second part of this two-part article will be published soon.



The *St. Paul Socony* and her six-barge tow pass through a swing bridge at Keokuk, Iowa.

Silhouettes of the slow-moving, low-slung tows are familiar sights to dwellers along the Mississippi.

TOWBOAT

'round the bend

P 614.2

WHEN the motor vessel *St. Paul Socony* tied up at Keokuk, Iowa, to await her turn to enter the lock at that upper Mississippi River town, her steward decided to try his luck with rod and reel. Several hours later, when the vessel began the process of "locking through," the steward had reeled in enough catfish to provide a generous side dish for each of the boat's 16-man crew at supper that night.

The incident was typical of the changeless nature of life along the Mississippi. Modernization, as seen in the supplanting of the old stern-wheelers by diesel-powered craft and in the construction of massive locks and dams, has left undimmed Old Man River's traditional charm. A leisurely moderation—of which the fishing pole is symbolic—still predominates along most of the river's winding course. The towboats and barges, modern counterparts of the steamboats of the past, are in the best river tradition. They will win no laurels for speed. Slow, but sure, their strong points are dependability and tremendous cargo-carrying capacity.

Despite the delay at Keokuk, the *St. Paul Socony* completed her up-river run from St. Louis to St. Paul in five and a half days, her fastest time for the 666-mile trip. That's a snail's pace in this day of 300-mile-an-hour air transportation. But, the *St. Paul Socony*, like scores of other river towboats, was doing a man-sized job. Ahead of her blunt bow were six steel barges lashed two abreast and riding deep in the water under the 8000-ton burden of 60,000 bbl (more than two and one-half million gallons) of Mobilgas. The cargo had been loaded at a pipe line terminus at Helena, Arkansas, for delivery to Socony-Vacuum's 314,000-bbl storage terminal at St. Paul and for final distribution by tank car and truck throughout Minnesota.

Commercial traffic long has moved on the Mississippi and its tributaries. However, it has been on the upper Mississippi that traffic has shown its greatest growth during recent years. This has been primarily because of river improvements, which have assured an adequate channel depth from St. Louis to Minneapolis. One result of the increased river transportation has been a tremendous expansion in petroleum storage facilities in upper river cities. Among these are Socony-Vacuum's bulk terminals at St. Louis; Davenport, Iowa; La Crosse, Wisconsin, and St. Paul.

River and harbor improvements have been carried out by the War Department's Engineers Corps, which operates the river's locks and dams and handles the dredging that keeps the channel at required depth. The U. S. Engineers' records reveal that oil has become the number one cargo on the upper river. The record shows that last year petroleum products accounted for 53 per cent of all the traffic passing the lock and dam at Rock Island, Illinois, and that at the end of the year total oil cargoes had reached a new high of more than 15,000,000 bbl.

Oil is the number one cargo as commercial traffic increases on the upper Mississippi River and modern vessels and crews take their places in the tradition of Old Man River. For permission to publish this extremely interesting account of the factors involved in towing oil barges up the Mississippi we are indebted to *Socony-Vacuum News*, company publication of Socony-Vacuum Oil Company, Inc., where it first appeared.

The tow, as seen by the pilot, is guided into a standard lock 600 ft long. The lock's rear gate is open, permitting entry of the six-barge tow.

The towboat is placed between the barges and the wall to enable the entire tow to go through in one locking. Both gates are closed as the water level is raised.

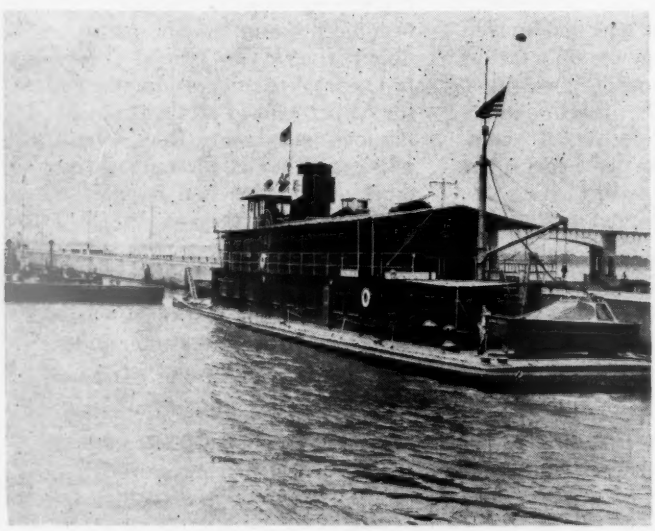
Coal, cement, sulfur, fabricated steel, automobiles, and a great variety of packaged goods also are moved by barge along the river. Yet, except for occasional congestion at one of the older, smaller locks, the broad highway provided by the river remains uncrowded.

Socony-Vacuum was one of pioneers in the transportation of oil products on the upper Mississippi, being one of the first companies to use its own towboats and barges. Its present western river fleet includes three towboats, the 147-ft *St. Paul Socony*, which is the flagship; the 137-ft *St. Louis Socony*, and the 125-ft *Kansas City Socony;* and 18 steel barges, each 195 ft long and with a capacity of 10,000 bbl. The company's river operations began in 1937 when the *Kansas City Socony* went into service.

Channel improvements along the river have brought a change in the type of towboats commonly used. Motor vessels powered by diesels, which drive propellers and require greater draft, are rapidly supplanting the familiar river steamboat with stern paddle-wheel.

Today's trend is toward larger, more powerful towboats and bigger barges. The greater power is needed to provide greater margins of speed for the battle against the strong river currents. The currents are especially formidable in the lower river when the river rises suddenly because of heavy rains farther north. To meet the river's challenge, some of the more powerful towboats develop around 3000 hp; there is one craft in operation with more than 5000 hp. As a result of the power increases, speeds against the current are moving up from 2 and 3 miles an hour to 5 and 6 miles an hour. In the upper river, where the dams have made the cur-

Tow is moved through open forward gate as towboat resumes its position behind the barges.



Deckhands take up slack in cables, which tie the barges into a compact unit.

rents negligible, higher speeds are attained.

The majority of river tows do not exceed more than six, and occasionally eight, barges. An example of the trend toward larger units, however, is a 15-barge tow, which is longer than the *Queen Mary* and has a greater cargo capacity than a T-2 ocean tanker of 16,750 deadweight tons. New barges are not only being built longer, but are designed for easier passage through the water. The largest have capacities of 22,000 bbl each—more than twice the capacity of the standard barge—and have their bows swept up in great tapering "rakes", which bring a substantial reduction in water resistance.

Many of the tows used on the river are "integrated" tows, an innovation pioneered by Socony-Vacuum in 1940. Under this arrangement, the bows of the forward barges and the sterns of those aft are "raked", while the center barges are square at both ends. Thus, the barges fit snugly together to form, in effect, a single unit capable of easier passage through the water.

Key to the present day navigation of the upper Mississippi is a series of 26 locks and dams spotted along the 673-mile stretch between St. Louis and Minneapolis. This river improvement project took 10 years and $150,000,000 to complete. It has created great pools, averaging about 26 miles in length, which have obliterated the former rapids and shallows and eliminated the currents that made earlier navigation a problem. The locks and dams have made possible a 9-ft channel, which means an assured depth of 9 ft at all times for heavy river traffic between St. Louis and Minneapolis.

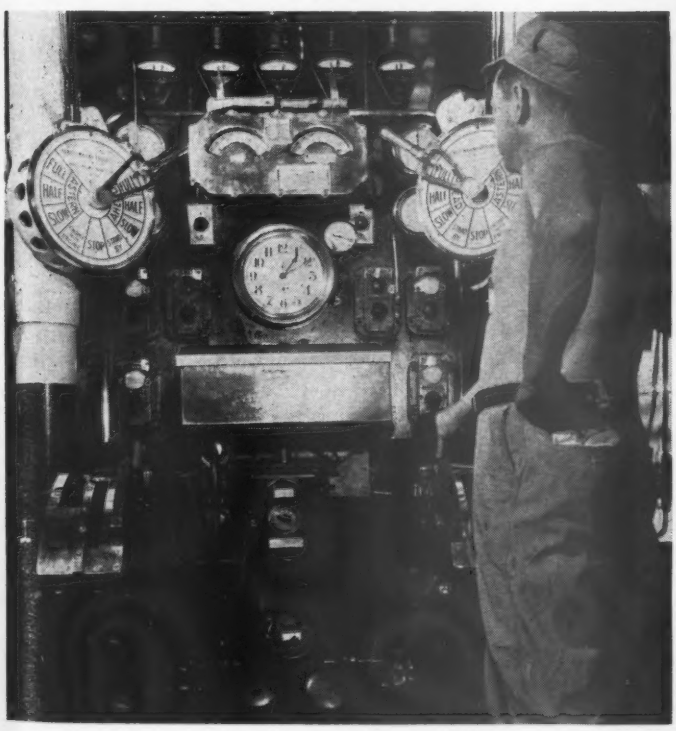
The improvements have revolutionized navigation on the upper river. Today, instead of fighting its way upstream through shallows and swift currents, river traffic climbs step by step up the giant stairway formed by the pools. The lift of the locks varies from 5.5 to 38.2 ft and a vessel is lifted a total of 326 ft during a trip from St. Louis to Minneapolis.

Last of the hazards on the upper river is the treacherous Chain of Rocks, just above St. Louis, where the river, rushing over a rocky bed, makes a sweeping curve. There, the current, especially during low water, often forces tows off course and runs them aground on the surrounding shallows. Tows are often halted by the current and forced to "double-trip." That means tying several barges to the bank, moving the remainder upstream to slower water and then returning to pick up the others. Even the Chain of Rocks' days are numbered: Work has already been started by the government on a canal that will by-pass the hazard.

Despite improvements along the river, individual skill and experience

At dusk the Mississippi takes on a soft beauty as a deckhand places navigation lanterns in position on the tow's barges.

Oscar Heil, assistant chief engineer of *St. Paul Socony*, stands ready in the engine room as the towboat approaches a lock. Prompt response to signals from the pilot house is vital as the towboat maneuvers in the close confines of a lock chamber.



Two crew members, right, splice an eye in the end of a line. The crew has few idle moments during a long river trip.

The messroom is a popular spot with crew members for the food is plentiful and tastefully prepared.

The steward of the *St. Paul Socony* prepares lunch in a well-stocked, spotlessly clean galley.

are needed to guide the tremendous tows along the stream's twisting course. Although the river channel is well-marked by buoys, the pilots must be on the watch for changing conditions—sandbars that shift their positions, and currents and depths that are constantly altered with the rise and fall of the river. In the narrower sections, especially at night, they must exercise caution in respect to other craft for sometimes there is scarcely space to pass.

Fog, one skipper says, is the riverman's worst enemy. When the white shroud starts to close in, there is nothing to do but tie up, before shorelines, river and all except the handrail in front of the pilot house are blotted out. Night thunderstorms have a weird fascination on the river. Curiously enough, the worse the storm the better the pilots like it, because incessant lightning keeps both river banks almost constantly illuminated. One pilot says he actually enjoys the electrical storms.

To make navigation easier, the towboats push rather than pull their tows. Towboat and barges, lashed securely together, form a compact unit that may be more easily maneuvered through the curving channel than would be the case if the barges were strung out astern on cables. The factor of visibility is vital, too. From his elevated position in the pilot house, the captain has the entire tow within his immediae range of vision. For sharp turns and close maneuvering—as when the barges are being docked and split up for unloading—the tow captain makes full use of his twin diesels. One engine may be full ahead, the other full astern. Double sets of rudders, one placed aft and one forward of each propeller, also help when precision steering is required.

The locks present their own challenge to the river pilot. Except for the old and undersized lock at Keokuk, the locks are each 600 ft long and 110 ft wide. These dimensions are ideally suited to the *St. Paul Socony* and her six-barge tow for the entire unit goes through with one locking. The barges are first eased into the lock flush against the landward wall, their 585-ft length extending almost the length of the lock. The towboat is then released, swung a few feet aft in a gentle arc and moved forward into the narrow space between the barges and the lock's river wall. Later, when water has been pumped into the lock and the forward gates opened, the towboat, secured to an aft barge, moves the tow ahead and then swings back to her normal position astern of the tow. The operations require split-second timing by a skilled mate and deckhands, as well as close cooperation between the pilot and the engine room.

At Keokuk, the situation is more difficult. There, for example, the *St. Paul Socony* needs three lockings to get through. The two forward barges are put through first, to be followed by the center barges and, on the final locking, the towboat and two aft barges. It's a slow process and tows are often held up as much as eight hours waiting their turns to lock through. Present proposals call for a 1200-ft lock to end the bottleneck at Keokuk. First of the river locks, the Keokuk lock was built in 1913 as part of a privately-owned hydroelectric plant.

At population centers the towboats attract considerable attention. The vessels have individualities of their own and usually are recognized long before their respective markings can be seen. River dwellers, for instance, can identify the *St. Paul Socony* before they can make out the Flying Red Horse atop the pilot house or the big Mobiloil and Mobilgas signs on the barges. Motorists slow down to watch the tows, while residents, bridge-tenders, fishermen, and Sunday picnickers wave friendly greetings. The locks help break the monotony of a long haul up-river. Lock-tenders and assistants come out to chat and mail is put ashore. Often there's time to walk into town for a newspaper.

Crew members of a modern towboat enjoy comfortable quarters and good meals. Their boat is usually clean and freshly painted. Aboard Socony-Vacuum's boats they work two six-hour watches a day and are on duty 40 days, off 20. In addition, they get two-week vacations.

Today's rivermen are taking their place in Mississippi River tradition. The romance of the river is timeless. The ghost of Mark Twain, for instance, seems close by when the riverman passes Hannibal, Missouri. So, too, it seems, are the spirits of Tom Sawyer and Huck Finn as they tie their raft to a willow and set out to explore one of the islands in midstream. Once in a while, in the dead of night, there occurs an incident that must make the modern riverman feel more strongly than ever his ties with the river's storied past. That's when the *Gordon Greene*, last of the river packets, glides by with lights aglow. As they wave a friendly greeting across the narrow strip of water that separates them, the merry-makers on the packet's deck and the crewmen of the towboat know alike the romance of the ageless Mississippi. * * *

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Compression Cylinder Design for Gas Transmission Pipe Line Systems

Variations From Fixed Conditions Necessitate Loading Engines for Considerable Range of Compression Ratios

B. T. MAST*

In the past it has been the general practice of designers of gas transmission systems to design on the basis of fixed operating conditions whereby compressor cylinders were selected to load the engines at a specific compression ratio and for the exact volumes to be handled. Not too much attention was paid to possible variations from these fixed conditions. An inspection of the operating conditions of the Tennessee Gas Transmission system over the period of years it has been in operation has revealed that the compression ratios have varied from as high as 2.1 to as low as 1.15. In Fig. 1, this variation has been plotted for two stations on Tennessee's system. Other stations reflect similar variations in ratios. There are a number of reasons for these varying ratios, including:

(a) Changing purchase points and volumes in relation to the location of the plant.

(b) Changing sales points and volumes.

(c) New pipe line loops (placed in service but not fully utilized due to other incompleted loop lines).

(d) Gradual increase in volumes handled due to progressively placing new facilities in service.

Compressor cylinders are required, therefore, that will load engines for a considerable range of compression ratios.

Definition of Terms

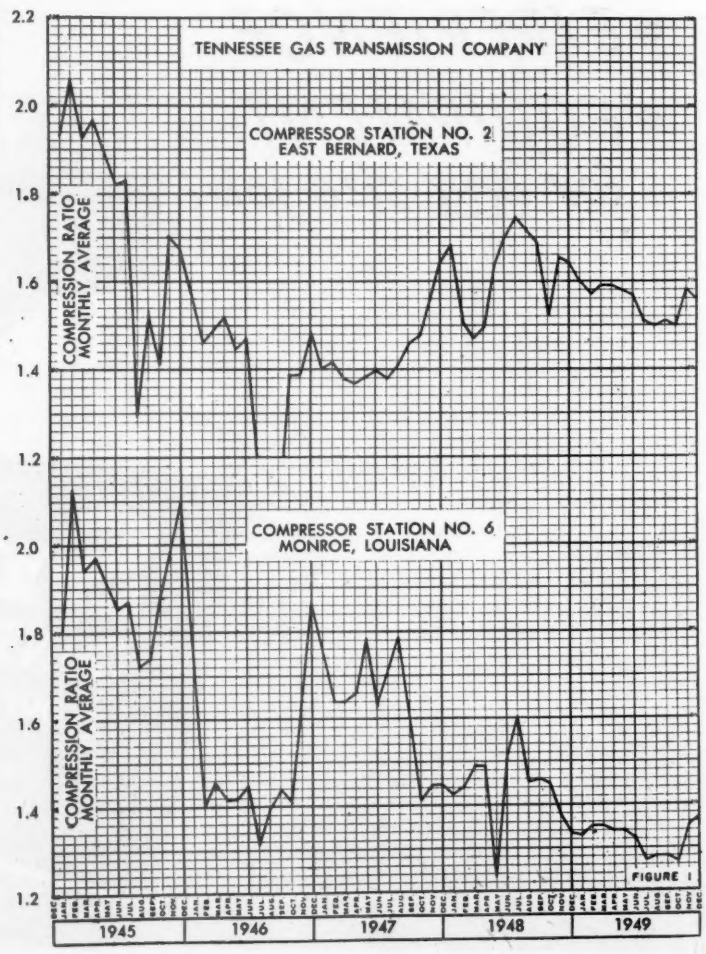
In order to define the terms to be used, attention is called to Fig. 2. In the first indicator card, the area between the suction and the discharge lines will be defined as a measure of the net indicated horsepower. This horsepower will then represent the useful work in terms of pipe line pumping capacity. The work represented by the other indicator card will be defined as the gross indicated horsepower. The difference between the net and gross horsepowers is the losses caused by valves and passageway restrictions and pipe friction. These overall losses will be called waste. To convert the indicated horsepower to brake horsepower, a 95 per cent mechanical efficiency seems to be in general usage and, therefore, will be used in calculating brake horsepower.

Engine Tests

During the last several months indicator card tests have been made on each type of engine and compressor cylinders installed on the Tennessee Gas Transmission Company pipe line system. The indicator cards were obtained with a balanced pressure type indicator.

In Fig. 3, indicator cards are shown for a typical cylinder operating under compression ratios of 1.24, 1.41, and 1.68. It should be noted that the waste is a considerable portion of the indicator cards. In the last card in Fig. 3, the dotted line represents the pressure in the suction and discharge lines im-

FIG. 1



*Engineer, Tennessee Gas Transmission Company.

EXCLUSIVE

mediately adjacent to the cylinder, reflecting some surging. Indicator cards from other type cylinders reflect similar waste but not necessarily the same percentage of the total horsepower.

The value of the waste as a percentage of the total engine load has been plotted for several cylinders on Fig. 4. Curves A through C are of cylinders equipped with one 6-in. suction and one 6-in. discharge valve in each end of the cylinders. Curves D and E are of cylinders with approximately the same displacement, but with two 6-in. suction and two 6-in. discharge valves in each end of the cylinders. As Curves D and E reflect materially lower values of waste, it is apparent that losses through the valves are of considerable magnitude. Curve F is of the same cylinder as Curve D but with the cylinder lined to a larger diameter. The percentage of waste increased as more gas was passed through the same valves. It is evident, therefore, that valve area is of major importance in compressor cylinder design. Curve G represents an experimental cylinder, which will be dealt with later. Inasmuch as the displacement of these cylinders was approximately the same but the losses varied considerably from cylinder type to cylinder type and also varied with changes in compression ratio, average values of the losses cannot be used and any cylinder selection to load an engine must take into account the losses in that specific cylinder. In order to obtain a means of calculation of engine loading in which these losses can be taken into account and in which the variation of loading with changing compression ratios will be reflected, the following formula is presented. This formula is to be used to calculate the basic, or theoretical horsepower only, valve losses to be added on the basis of engine test data.

FIG. 2

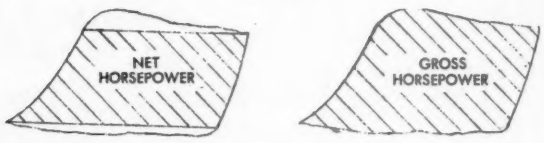


FIG. 3

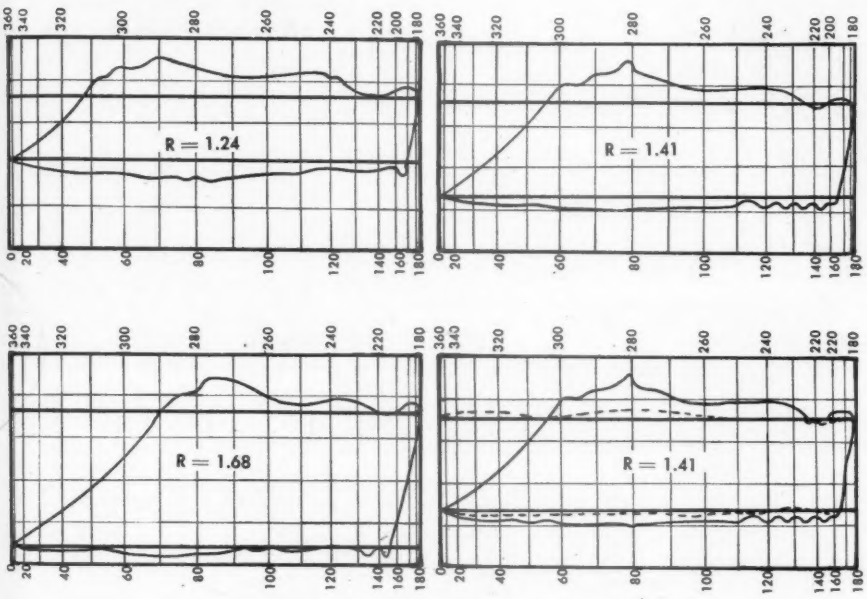
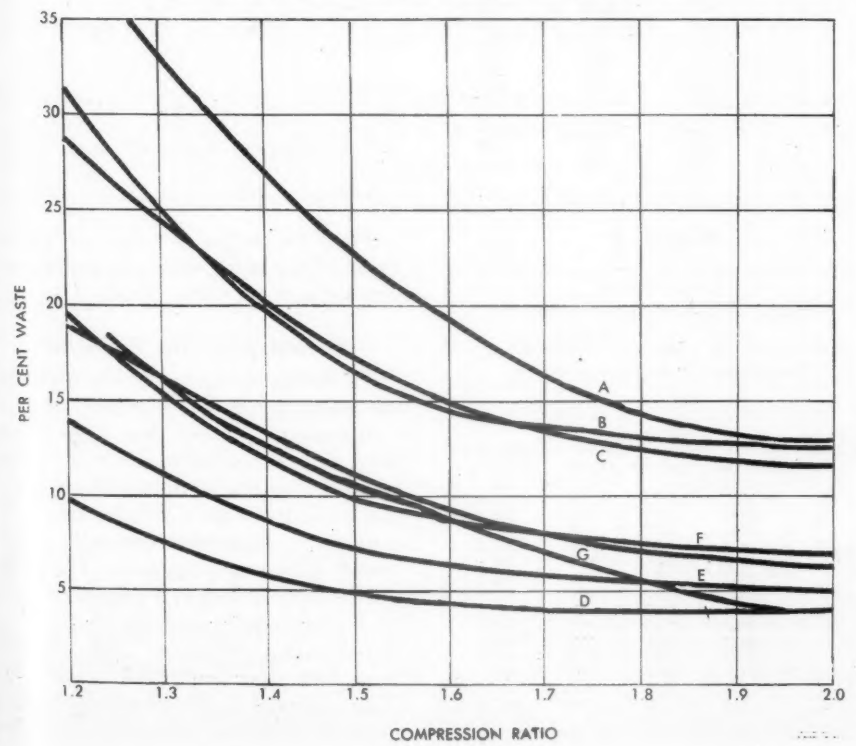


FIG. 4. Compressor cylinders, valve, passages and piping losses in per cent of engine load.



Tennessee Gas Compression Formula

Indicated horsepower net =

$$\frac{LAN}{33{,}000} \times \frac{n}{n-1} \times P_s \left[\frac{R^{\frac{n-1}{n}} - 1 - m}{\left(1 + R - R^{\frac{1}{n}} - R^{\frac{n-1}{n}}\right)} \right]$$

Where:

L = length of stroke, ft
A = area of piston, sq in.
N = revolutions per minute
n = exponential function in the general formula for gases PV^n = A constant
P_s = suction pressure, psia
R = compression ratio

$$m = \frac{\text{Clearance volume}}{\text{Displacement volume}} = \frac{\text{Per cent clearance}}{100}$$

Volumetric efficiency:

$$E_v = 1 - m\left(R^{\frac{1}{n}} - 1\right)$$

Derivation of Horsepower Formula

Using the conventional horsepower formula for a reciprocating piston:

$$IHP = \frac{PLAN}{33{,}000} = \frac{LAN}{33{,}000} \times P$$

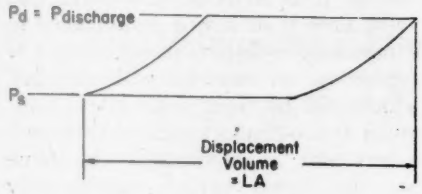
Where:

P = mean effective pressure and for a given cylinder, and

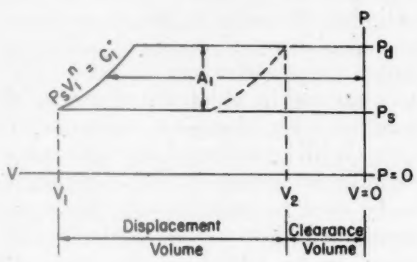
speed, P is the only variable with ratio.

Consider the pressure-volume diagram of the compression cycle, for a gas conforming to the general formula for gases:

$$PV^n = \text{Constant}$$



$$\text{MEP} = \frac{\text{Area of Pressure—Volume Diagram}}{\text{Displacement Volume}}$$

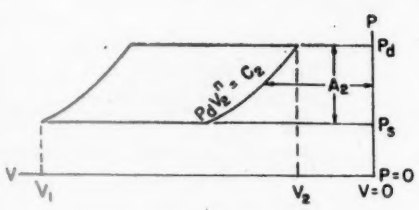


$$A_1 = \int_{P_d}^{P_s} \frac{C_1^{\frac{1}{n}}}{P^{\frac{1}{n}}}$$

integrating to the P axis.

V_1 = displacement volume plus clearance volume

V_2 = clearance volume



$$A_2 = \int_{P_d}^{P_s} \frac{C_2^{\frac{1}{n}}}{P^{\frac{1}{n}}}$$

integrating to the P axis.

$$\text{MEP} = \frac{\int_{P_d}^{P_s} \frac{C_1^{\frac{1}{n}}}{P^{\frac{1}{n}}} - \int_{P_d}^{P_s} \frac{C_2^{\frac{1}{n}}}{P^{\frac{1}{n}}}}{\text{LA}}$$

$$\text{I.H.P.} = \frac{\text{LAN}}{33{,}000} \times \frac{\int_{P_d}^{P_s} \frac{C_1^{\frac{1}{n}}}{P^{\frac{1}{n}}} - \int_{P_d}^{P_s} \frac{C_2^{\frac{1}{n}}}{P^{\frac{1}{n}}}}{\text{LA}} = \frac{\text{LAN}}{33{,}000} \times$$

$$\frac{C_1^{\frac{1}{n}}\left[\frac{{}_nP_d^{\frac{n-1}{n}}}{n-1} - \frac{{}_nP_s^{\frac{n-1}{n}}}{n-1}\right] - C_2^{\frac{1}{n}}\left[\frac{{}_nP_d^{\frac{n-1}{n}}}{n-1} - \frac{{}_nP_s^{\frac{n-1}{n}}}{n-1}\right]}{\text{LA}}$$

Substituting:

$P_d = RP_s$

$C_1 = P_sV_1^n$

$C_2 = P_dV_2^n = RP_sV_2^n$

$$= \frac{\text{LAN}}{33{,}000} \times \frac{n}{n-1} \times$$

$$\frac{\left[P_s^{\frac{1}{n}}(V_1 - R^{\frac{1}{n}}V_2)\right]\left[P_s^{\frac{n-1}{n}}(R^{\frac{n-1}{n}} - 1)\right]}{\text{LA}}$$

Substituting:

$V_1 = \text{LA} + m\text{LA}$

$V_2 = m\text{LA}$

$$\text{I.H.P.} = \frac{\text{LAN}}{33{,}000} \times \frac{n}{n-1} \times P_s$$

$$\left[R^{\frac{n-1}{n}} - 1 - m\left(1 + R - R^{\frac{1}{n}} - R^{\frac{n-1}{n}}\right)\right]$$

For practical applications,

Let: $R^{\frac{n-1}{n}} - 1 = H$

$$1 + R - R^{\frac{1}{n}} - R^{\frac{n-1}{n}} = B$$

Then for a given value of n, the values of H and B can be set up in a tabular or graphic form. (See Table 1 for illustration).

$$\text{I.H.P.} = \frac{\text{LAN}}{33{,}000} \times 4.5714 \times P_s\,(H - mB)$$

Further—for a given stroke L and speed N, $\frac{\text{LAN}}{33{,}000}$ factors for different diameter cylinders can be set up. (See Table 2 for illustration).

TABLE 1.

Ratio	H	B	C
1.20	0.0407	0.0062	0.1531
1	.0426	.0068	.1606
2	.0445	.0074	.1681
3	.0463	.0081	.1755
4	.0482	.0088	.1830
1.25	0.0500	0.0095	0.1905
6	.0519	.0102	.1979
7	.0537	.0110	.2053
8	.0555	.0118	.2127
9	.0573	.0126	.2201
1.30	0.0591	0.0134	0.2275
1	.0608	.0143	.2349
2	.0626	.0152	.2422
3	.0644	.0160	.2196
4	.0661	.0170	.2569
1.35	0.0679	0.0179	0.2642
6	.0696	.0189	.2715
7	.0713	.0199	.2788
8	.0730	.0209	.2861
9	.0747	.0219	.2934

TABLE 2.

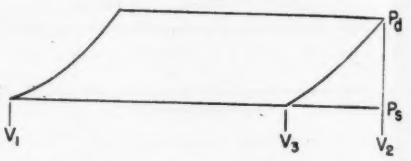
Cylinder displacements and $\frac{\text{LAN}}{33{,}000}$ factors

L = 14 in. N = 300 rpm 3 in. piston rod

Displacement is for double acting cylinders

Cylinder diameter, inches	$\frac{\text{LAN}}{33{,}000}$ factors			Displacement MCF/day
	Head end	Crank end	Average	
6½	0.3536	0.2767	0.3152	207.5
¾	.3795	.3044	.3420	225.8
7	.4081	.3331	.3706	244.7
¼	.4378	.3628	.4003	264.2
½	.4686	.3936	.4155	284.5
¾	.5003	.4253	.4628	305.5
8	.5332	.4582	.4957	327.1
¼	.5670	.4920	.5295	349.5
½	.6020	.5269	.5645	372.5
¾	.6377	.5628	.6002	396.2
9	.6748	.5998	.6373	420.6
¼	.7127	.6377	.6752	445.7
½	.7518	.6768	.7143	471.4
¾	.7918	.7169	.7544	497.9

Derivation of Volumetric Efficiency Formula



V_2 = clearance volume = mLA

V_1 = displacement volume plus clearance vol. = (1 + m) LA

$$P_dV_2^n = P_sV_3^n$$

$$V_3 = \left(\frac{P_dV_2^n}{P_s}\right)^{\frac{1}{n}} = \left(RV_2^n\right)^{\frac{1}{n}}$$

$$= R^{\frac{1}{n}}V_2 = R^{\frac{1}{n}}m\text{LA}$$

$$\text{Volumetric efficiency} = E_v = \frac{V_1 - V_3}{V_1 - V_2}$$

$$= \frac{(1+m)\,(\text{LA}) - m\text{LA}R^{\frac{1}{n}}}{(1+m)\,\text{LA} - m\text{LA}}$$

$$= \frac{\text{LA}\,(1 + m - mR^{\frac{1}{n}})}{\text{LA}}$$

$$= 1 - m\,(R^{\frac{1}{n}} - 1)$$

For practical application—

Let: $R^{\frac{1}{n}} - 1 = C$

Then for a given value of n, the value of C can be set up in tabular or graphical form. (See Table 1.)

Accuracy of Hp Formula

To test the accuracy of the formula, the load curve for several types of compressor cylinders has been calculated and compared to the load curves of the cylinders as determined by actual cylinder tests. Cylinder test indicator cards were obtained with a balanced pressure indicator. The tests were made on Cooper Bessemer GMV-10 engines equipped with type C3C—7½-in. diam cylinders, C4B—7½-in. diam cylinders and C5A — 8¾-in. diam cylinders; Worthington LTC-8 engines equipped with 8¼-in. diam

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Calculated and indicated load curves—indicated horsepower net per cylinder.

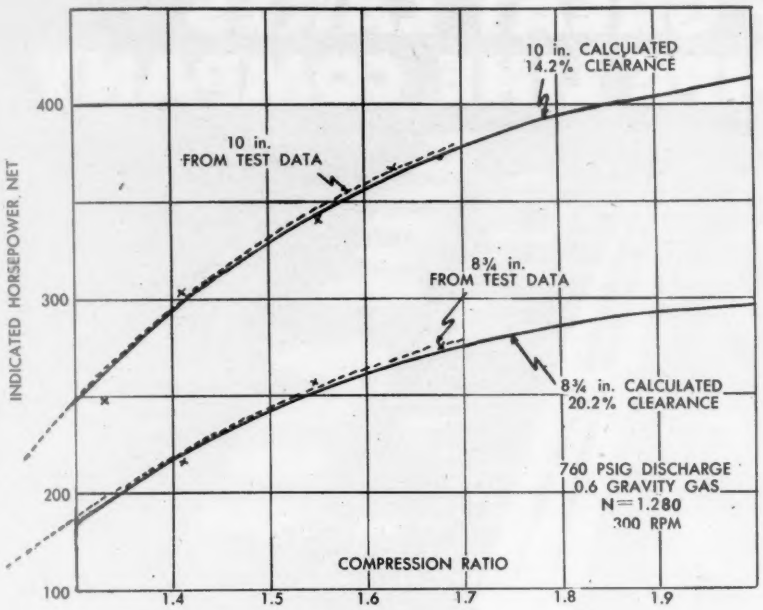

FIG. 5

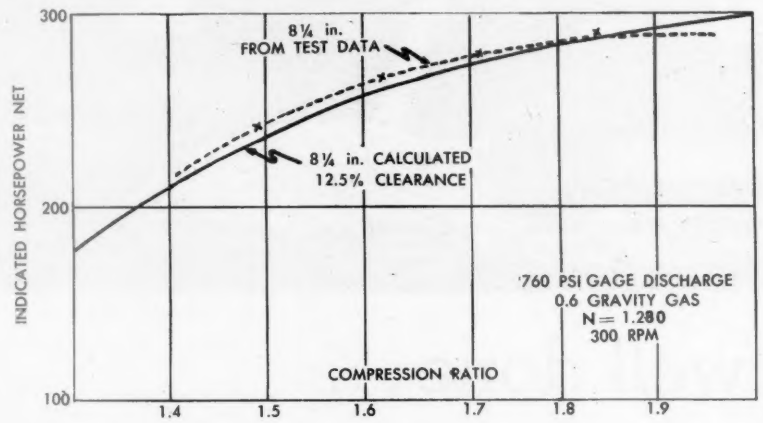

FIG. 6

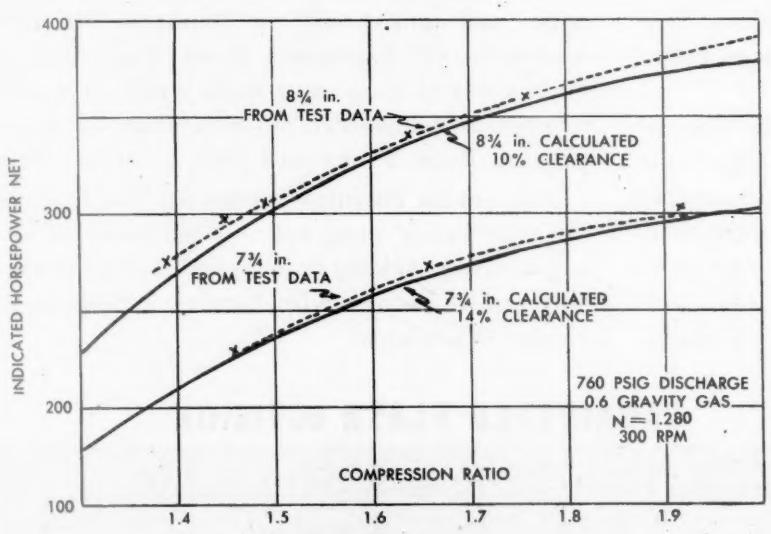

FIG. 7

cylinders; Clark BA-6 engines with 7¾-in. diam cylinders; Clark BA-8 engine with 8¾-in. diam cylinders; and Cooper Bessemer Type 26 horizontal engines equipped with 13½-in. diam cylinders.

This range of sizes, 7½ in. to 13½ in.; strokes, 14 in. to 36 in., and speeds, 125 to 300 rpm, can be considered a rather comprehensive test.

The following curves (Figs. 5, 6, and 7) have been plotted to compare the load curve calculated by the Tennessee Gas Formula and the load curve established by the test data on these cylinders. It should be noted that the test curves do not vary more than 3 per cent from the calculated curve at any of the loads tested. The variation of the test curve from the calculated curve is largely due to using an average clearance value in the formula calculations when the clearance in the individual cylinders will vary slightly from the average.

Application of Formula

In examining the formula it can be seen that once a cylinder size is selected, the LAN factor becomes a constant, and horsepower varies only with the mean effective pressure. It is also apparent that at a constant discharge pressure the mean effective pressure will vary only with compression ratio and clearance. The variation of mean effective pressure with changing ratios and clearances has been plotted in Fig. 8.

It is not feasible to design a cylinder that will load an engine to a fixed power output over a wide range of ratios; therefore, the allowable load variation must first be determined. On present day 2-cycle engines the fuel consumption curve is generally at a minimum at the rated load of the engine and relatively flat between 95 and 105 per cent of rated load. The fuel consumption then usually increases rapidly outside this range load. Therefore, if cylinders are designed to hold the engine between 95 and 105 per cent rated load, the most economical operation should be obtained.

Referring to Fig. 8, if a peak mean effective pressure condition of 105 per cent load is selected, then 10 per cent less MEP would represent 95 per cent load. On the individual clearance lines the 95 per cent load point has been determined and dash lines drawn to indicate these load points. For example, a cylinder with 30 per cent clearance will stay within 5 per cent of full load between ratios of 1.6 and 2.7 with the peak horsepower of 105 per cent occurring at a ratio of 2.1.

A cylinder designed to load an engine for pipe line transmission service

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WHERE you need an extra range of digging widths and depths for biggest pipeline jobs, check Parsons 310 Trenchliner . . . the industry's largest ladder-type trencher. You get trenches up to 17 feet deep . . . 1½ to 4½ feet wide. Oversize teeth and special side-cutters provide 16 widths, with only 4 standard bucket sizes. Extra-wide boom carriage takes dual booms for trenching 6 feet wide at 11 foot depth.

Maximum digging power is transmitted by roller-chain drive direct to bucket line . . . produces 8 inches to 15½ feet of trench per minute. Selection of 45 digging feeds gives you maximum digging efficiency at any depth, width, and in all types of materials. You never need worry about overload. When heavy-duty, cast-steel digging buckets strike obstruction in trench, band-type safety clutch automatically slips over drum, dissipates any shock load.

Other production-boosting features on the big capacity 310 include: shiftable boom, digs behind either crawler . . . power-shift arc-type conveyor, shifts completely through machine in less than a minute, discharges spoil on either side. All gears, anti-friction bearings and shafts enclosed in unit-type main gear case run in continuous oil bath . . . assure long, trouble-free operation. It will pay you to get full facts. Call your Parsons oil field distributor, or send now for 310 Trenchliner bulletin.

PARSONS COMPANY, Newton, Iowa

Digs

- **17′ DEEP. Telescopic boom locks at 14″ depth intervals.**
- **1½′ TO 4½′ WIDE With dual booms, digs 6′ wide.**
- **8″ TO 15½′ PER MINUTE 45 digging feeds . . . 5 reverse.**

Mail coupon today

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Send us new 12-page bulletin on 310 Trenchliner

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Also interested in: ☐ 221 ☐ 250 crawler Trenchliners ☐ Rubber-tired Trenchmobile

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PARSONS *Trenchliners*®

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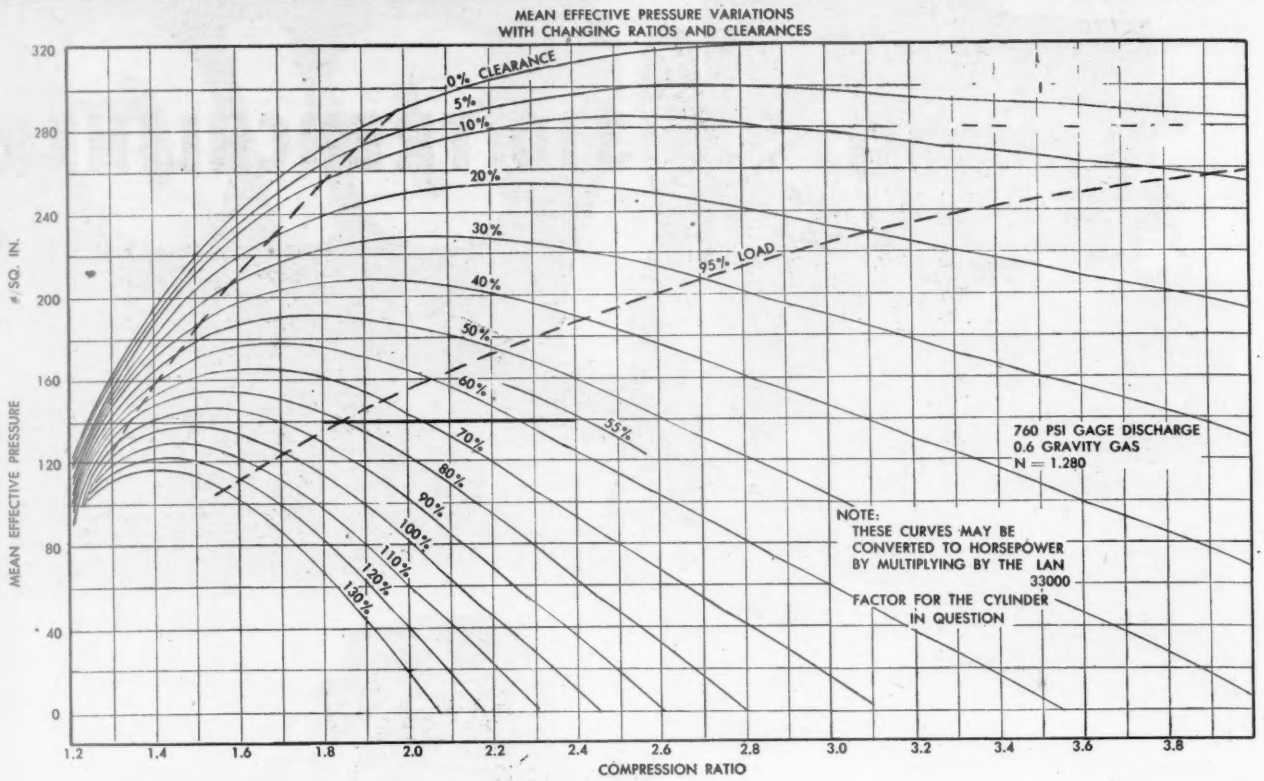


$$\text{Indicated horsepower net} = \frac{LAN}{33000} \times \frac{n}{n\text{-}1} \times P_s \left[R^{\frac{n\text{-}1}{n}} - 1 - m\left(1 + R - R^{\frac{1}{n}} - R^{\frac{n\text{-}1}{n}}\right)\right]$$

FIG. 8

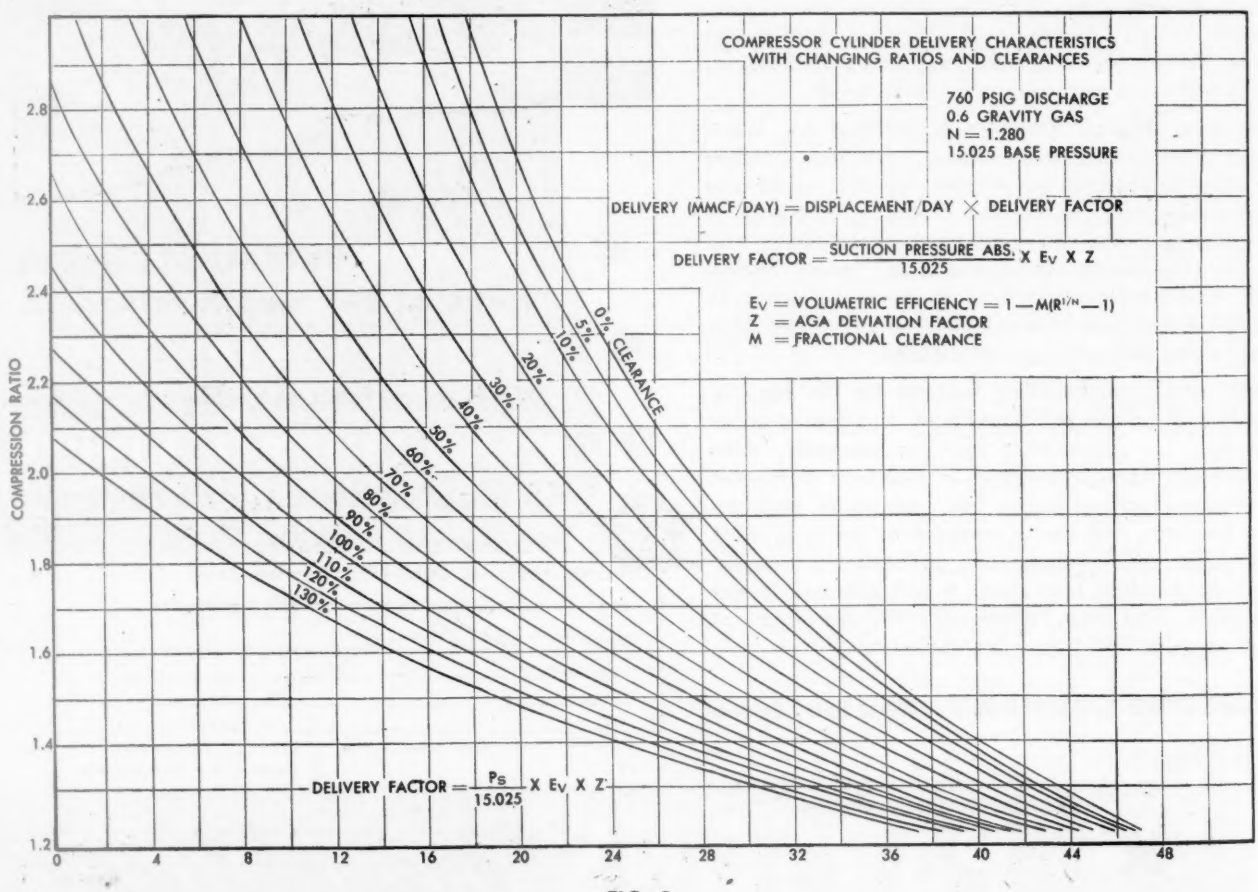


FIG. 9

EXTRA YEARS of pipe life

HERE

The longer the coating and wrapping stays positively bonded to your pipe... then the longer your pipe will resist every corrosive agent and operate free of costly leaks.

20" steel pipe, with Hill, Hubbell mill-*applied coating and wrapping, being laid in rugged Rocky Mountain terrain.*

thanks to the pipe protection process that includes VITAL WARM-UP

HERE

NO MOISTURE between pipe, primer, and succeeding coatings can endanger the effectiveness of Hill, Hubbell-applied protection. This is because Hill, Hubbell insists that all pipe pass through huge heating and drying rooms (*above*) before Roto-Grit-Blast cleaning and other processing. The pipe is pre-heated to 90°, drying off every trace of moisture. Then this temperature is *constantly maintained* until the entire coating and wrapping process is completed. This vital "warm-up" step is just one more reason why Hill, Hubbell *factory*-applied protection assures you far longer pipe life.

For a Quarter Century the Pioneer in Pipe Protection

Hill, Hubbell and Company

Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

between ratios of about 1.35 and 1.85, which in Fig. 8 would be an 80 per cent clearance, would cover most of the range of Stations No. 2 and 6. (See Fig. 1). A cylinder with this clearance would not require pockets and would maintain engine load within this range between 95 and 105 per cent of rated load. If it is desired to extend the load range to a ratio of 2.4, for example, it is merely necessary to follow the constant MEP line of 95 per cent load and 80 per cent clearance (a MEP of 140 psi) out to a 2.4 ratio and read the clearance, approximately 56 per cent. This clearance would then become the fixed clearance, and the difference between 56 per cent and 80 per cent, or 24 per cent, should be placed in pockets; hence with the pockets open, the cylinder would be operating on the total clearance of 80 per cent curve. This same clearance in pockets would extend the lower end of the operating range to a ratio of 1.29.

To determine the size cylinder required to load a given engine, the following procedure may be followed:

To load a 1000 hp engine with three double acting compressor cylinders, the load to remain within 5 per cent of full load between ratios of 1.35 and 1.85. Peak MEP = 154 psi, (Fig. 8).

Peak bhp = 105 per cent load = 1050 hp

Gross indicated hp
= bhp × mech. eff.
= 1050 × 95 per cent = 998 hp
= net hp + waste

In reference to Fig. 4, the per cent waste of the more efficient cylinders did not exceed 8 per cent at the peak horsepower (1.5 for 80 per cent clearance). Although the per cent waste increases with lower ratios, the net horsepower decreases more rapidly and the peak load will not exceed that calculated, provided the 8 per cent average waste is allowed at the peak horsepower. This is true only if the valving, passages, etc., of the cylinder is designed to equal or improve the performance of the cylinder from which the per cent waste curve was obtained. In other words, the waste value can only be assigned in terms of knowledge of the characteristics of similar cylinders. Continuing the determination of cylinder size:

Gross hp = 998 = net hp + 0.08 net hp

$$\text{Net hp} = \frac{998}{1.08} = 924 \text{ hp}$$

$$\text{Net hp (per cylinder end)} = \frac{924}{6}$$

$$= 154 \text{ hp}$$

$$154 \text{ hp} = P \times \frac{LAN}{33{,}000}$$

$$= 154 \times \frac{LAN}{33{,}000}$$

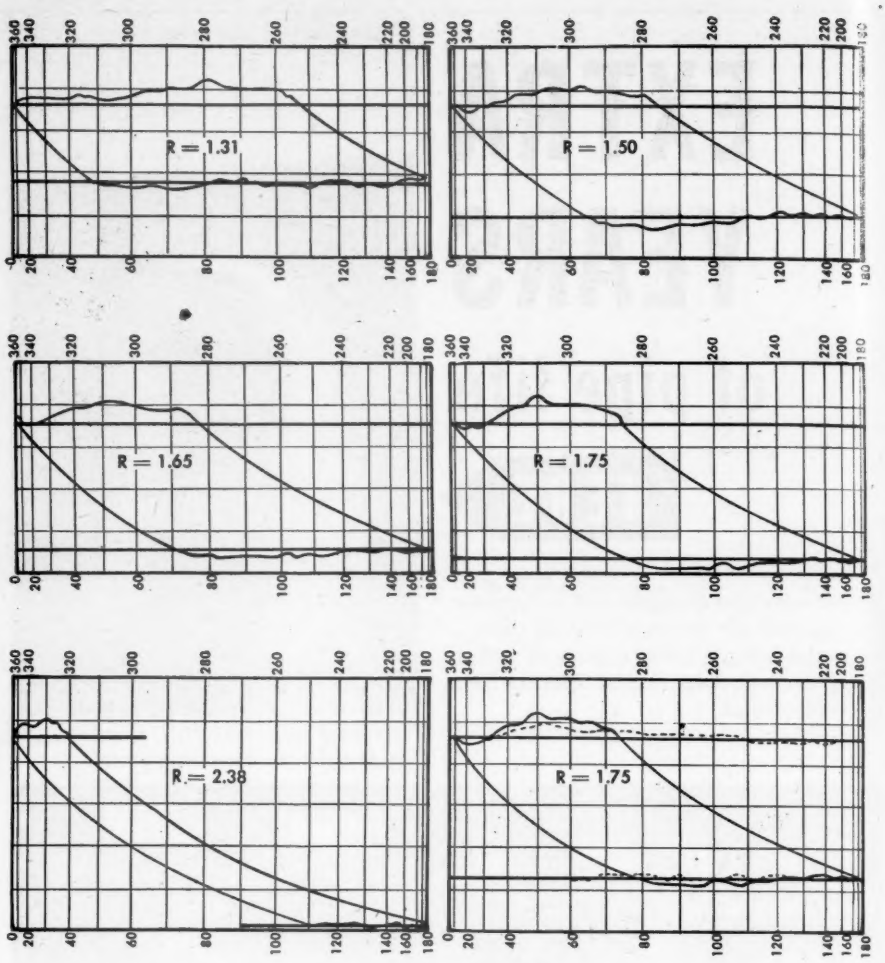


FIG. 10. Special test 11¾-in. cylinders.

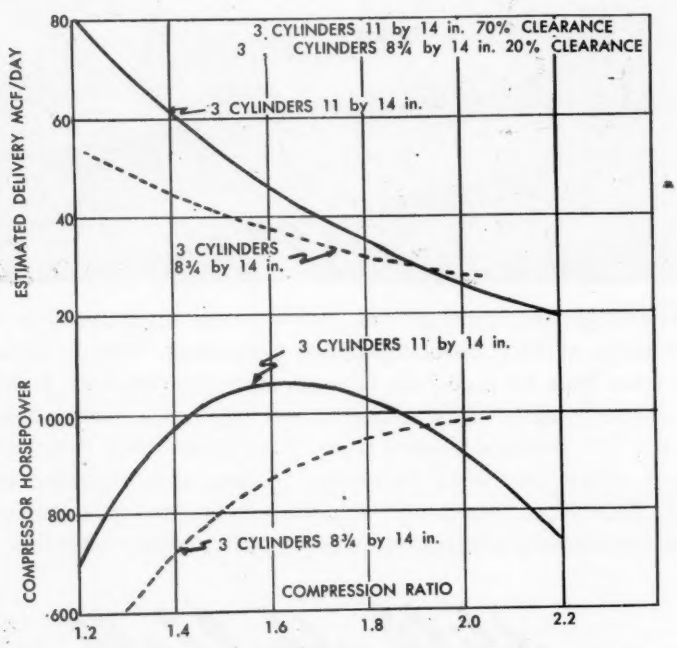
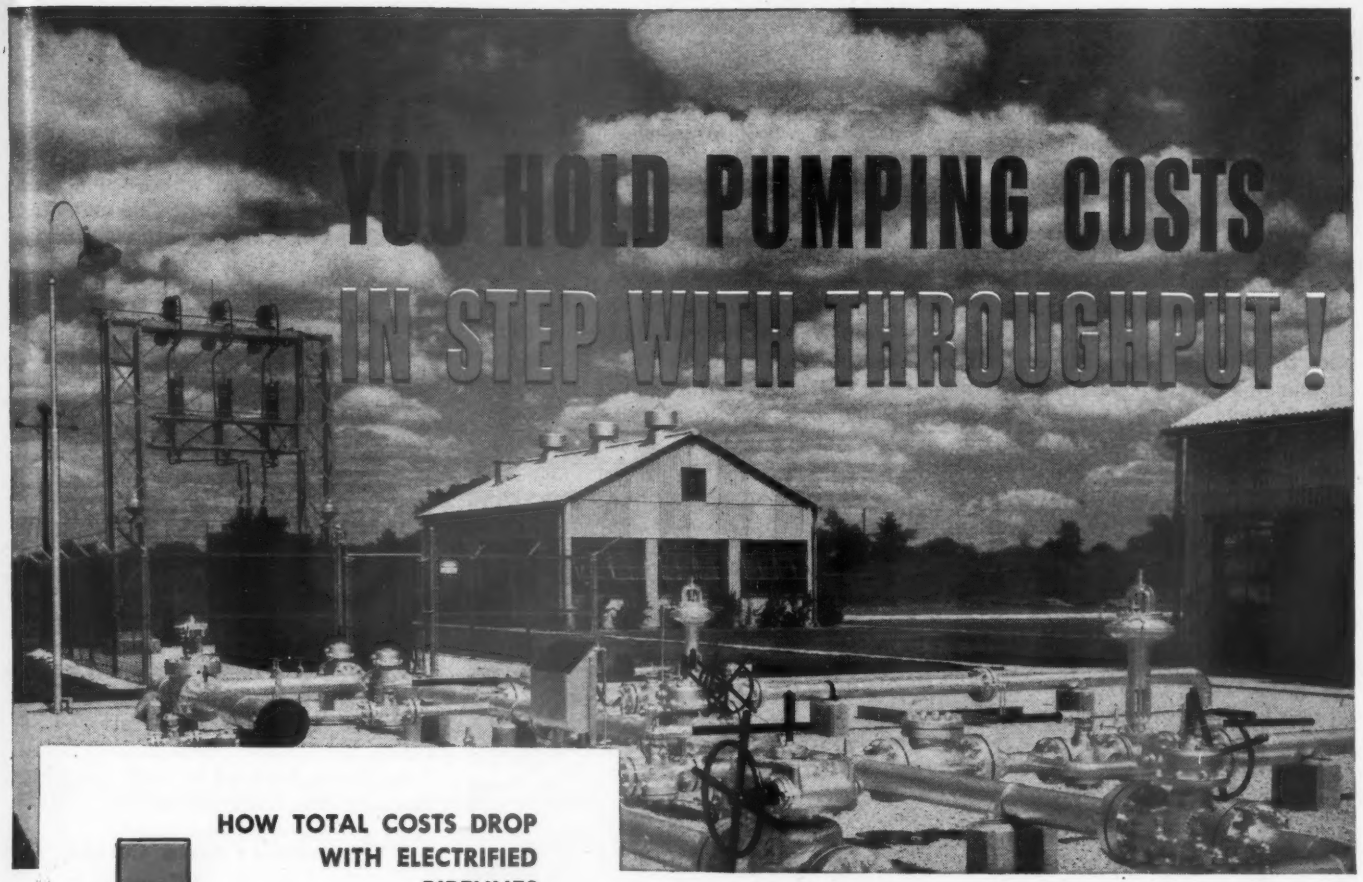
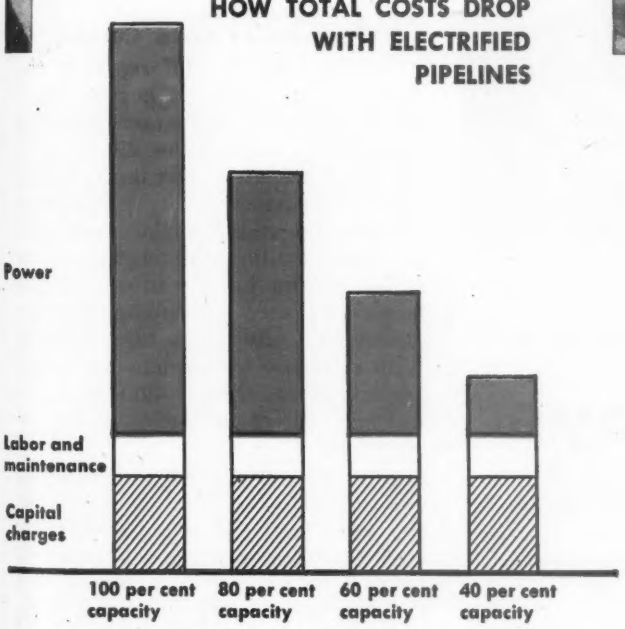


FIG. 11. Comparative performance curves for cylinders on 1000 hp engine.



HOW TOTAL COSTS DROP WITH ELECTRIFIED PIPELINES



With electric power, maintenance and labor costs are low and total operating costs drop sharply at reduced capacities, as this chart shows. Actual capacity factor of the nation's pipelines has always averaged less than 100 per cent annually, has even gone as low as 37.3 per cent.

DON'T MISS IT! Ask your G-E representative about a showing of "Lease on the Future," G-E's More Power to America program on how the oil industry is applying electric power with profit.

With electrical equipment, capital charges, labor and maintenance are low. Total operating costs with electrical equipment drop sharply as throughput goes down . . . and less power is used. This makes total operating costs correspond closely to throughput instead of being pegged at a high level. And here are other savings:

Reduces initial investment cost Lowest-cost equipment for oil pipeline pumping is the electric-motor-driven centrifugal pump.

Releases manpower for other duties Electric equipment needs little attention, lends itself readily to automatic control that further saves manhours.

Simplifies operation Automatic control minimizes the chances of human error, permits centralizing controls for greater efficiency.

Lowers maintenance costs Electric motors cost less to maintain than any other type of drive.

WHEN YOU "GO ELECTRIC," GO GENERAL ELECTRIC!

Here's what you get: (1) Everything electric you need from an extensive range of quality products. (2) Helpful services of skilled application engineers familiar with pipeline industry needs. (3) A complete, integrated electrical system when G.E. co-ordinates the selection, manufacture and shipment of all the equipment required. (4) Quick servicing of any G-E apparatus from the nearest of 30 service shops.

To electrify efficiently, call your nearest G-E office first. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

Everything you need to cut oil pipeline costs —ELECTRICALLY!

GENERAL ELECTRIC

$$\frac{LAN}{33{,}000} = 1.000$$

By substituting the length of stroke and the speed of the engine the cylinder diameter can be found.

It should be noted that Fig. 8 has been plotted for a discharge pressure of 760 psi; however, similar curves can be plotted for other discharge pressures and the relative curvature will not be changed.

Fig. 9 has been included to illustrate the shape of the delivery curve for various clearances. Actual measurement tests have not yet been made; however, volumetric efficiencies obtained from indicator cards have, in general, verified the theoretical calculations. If it is recognized that there is a possible error of the same magnitude as in the horsepower calculations (3 per cent) then this set of curves is useful.

Special Test

In order to test the accuracy of the formula, a special test was set-up. The cylinders of one engine were lined up from 8¾-in. bore to 11¾-in. bore, double deck or stacked valves designed by the manufacturer to increase the valve area, and a special short piston provided to fix the clearance at approximately 78 per cent. No pockets were used on the cylinders. Indicator cards from these cylinders may be seen in Fig. 10. The net horsepower curve followed the predicted curve developed from the formula within 3 per cent at all points between a 1.31 ratio and a 2.38 ratio. The per cent waste was that illustrated by Curve G, Fig. 4. The waste is approximately the same at the lower ratios as those of Curve F, which is the same cylinder with a 10-in. bore, standard valves, and small clearances. The increased valve area in the double decked valves decreased the waste in that it was held constant while increasing the cylinder bore from 10 in. to 11¾ in. Curve D is the same cylinder but with an 8¾-in liner, standard valves, and small clearances. Although the per cent waste is smaller for this cylinder, the 8¾-in. does not nearly load the engine at the lower ratios.

In reference to the indicator cards in Fig. 10, it should be noted that the areas of the cards for ratios 1.31 through 1.75 are about equal; therefore, the engine load is nearly constant through this range of ratios.

Comparative Load Curves

To illustrate the difference in the characteristic loading curves of a small clearance and a larger clearance cylinder for ratios below 2.0, Fig. 11 has been prepared. The larger clearance necessitates a larger diameter cylinder, the added displacement consequently loading the engine to its rating at the lower ratios and the larger clearance controlling the displacement loading at the higher ratios. With reference to the delivery curve, neglecting waste, the volume pumped will be in direct proportion to the engine load.

Although a small clearance cylinder can be designed to load the engine at the lower ratios, by using sufficiently large pockets, the small clearance will restrict the valving to such a degree that excessive waste will be encountered at the lower ratios.

Conclusions

1. Total clearance should be selected to cover the range of ratios within which it is most desirable for the engine to operate without the necessity of operating pockets.

2. If it is desired to extend the basic range of ratios, the fixed clearance should be determined by the highest ratio it is desired to cover with the engine at the specified load; however, it is believed that the fixed clearance should be held as high as possible, the extra clearance being used to increase the valve areas to the maximum possible extent. * * *

KANEWELD PIPE . . .
for Gas Highways

Expanded 30" pipe is rolling to location daily from KANEWELD'S production line. It's industry's best buy in line pipe today, thanks to a unique welding process—and other exclusive KANEWELD features.

KANEWELD PIPE CASING

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KANE BOILER WORKS, Inc. • GALVESTON, TEXAS

Looking for piping . . . for quality?
You'll find them both at CRANE

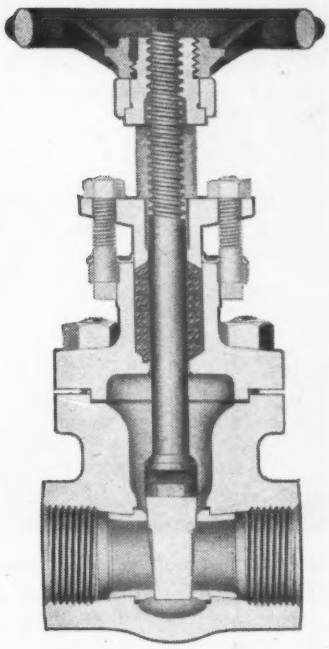
SMALL IN SIZE...BUT STRONG IN SERVICE

If you want better small steel gates, get these Crane 600-pound bolted bonnet valves. To begin with, they're strong—extra strong—but carry no excess bulk or weight. Fact is, they're unusually compact—yet include features you expect to find in larger or more expensive valves.

Features, for example, such as the closely guided disc that protects seating surfaces against unnecessary disc drag and wear. Or the strong but non-rigid disc-stem connection that prevents stem distortion and binding of parts.

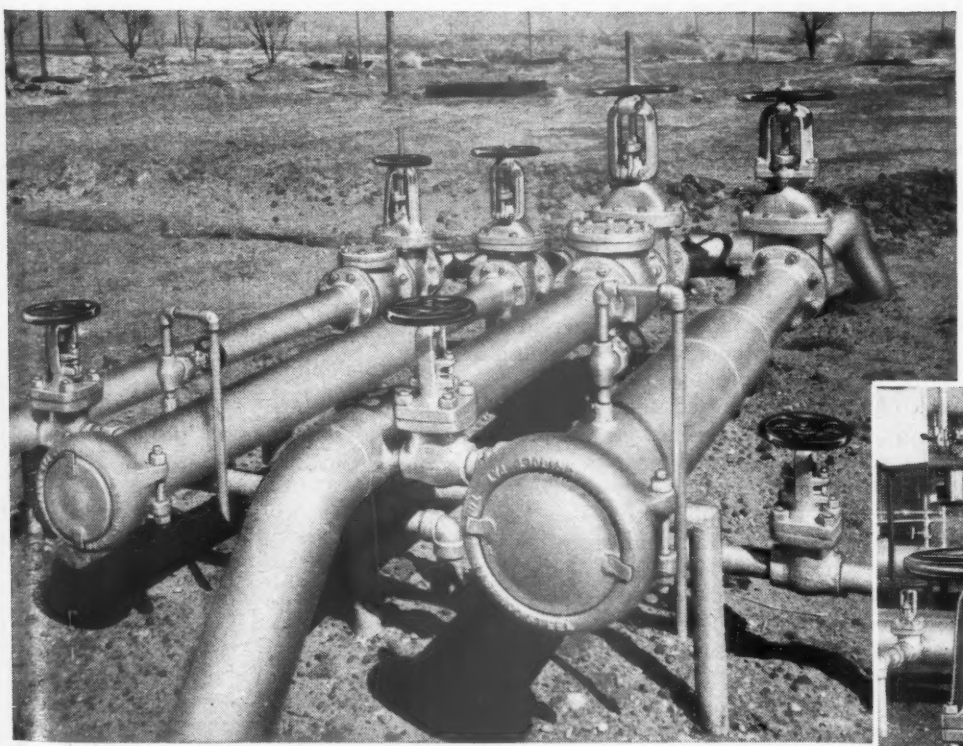
These valves assure maximum protection against leakage: stuffing box is deep, filled with high quality packing; male and female bonnet joint is securely bolted, equipped with soft iron gasket; body seat rings are rolled into place—will not loosen in service. See your No. 49 Crane Catalog.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



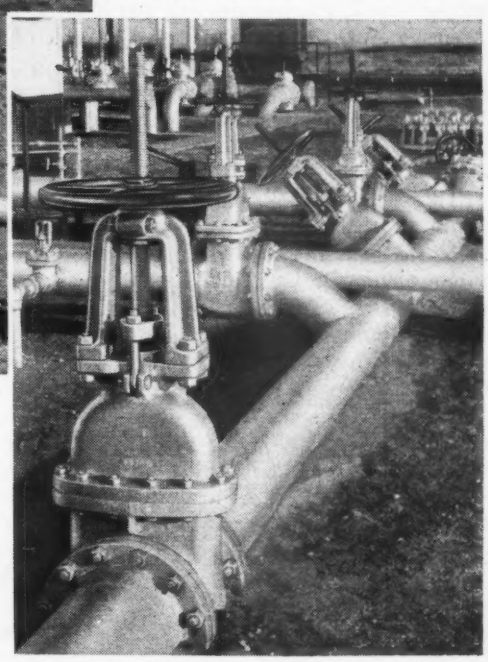
No. 3607X, 600-Pound Bolted Bonnet Small Steel Gate for oil or oil vapor up to 1000° F. Exelloy to Exelloy seating. Sizes: ½ to 2-inch. Screwed, flanged, or welding ends.

ONE ORDER TO CRANE MAKES AVAILABLE THE WORLD'S MOST COMPLETE SELECTION OF PIPING MATERIALS



SCRAPER TAKE-OUTS *on incoming field lines equipped with Crane 600-Pound Bolted and Union Bonnet Small Steel Gates, steel wedge gates, and steel checks.*

FIELD LINE TO SUCTION PUMP. *Crane equipment includes 6 and 8-in. steel valves, flanged and screwed fittings.*



EVERYTHING FOR EVERY PIPING SYSTEM

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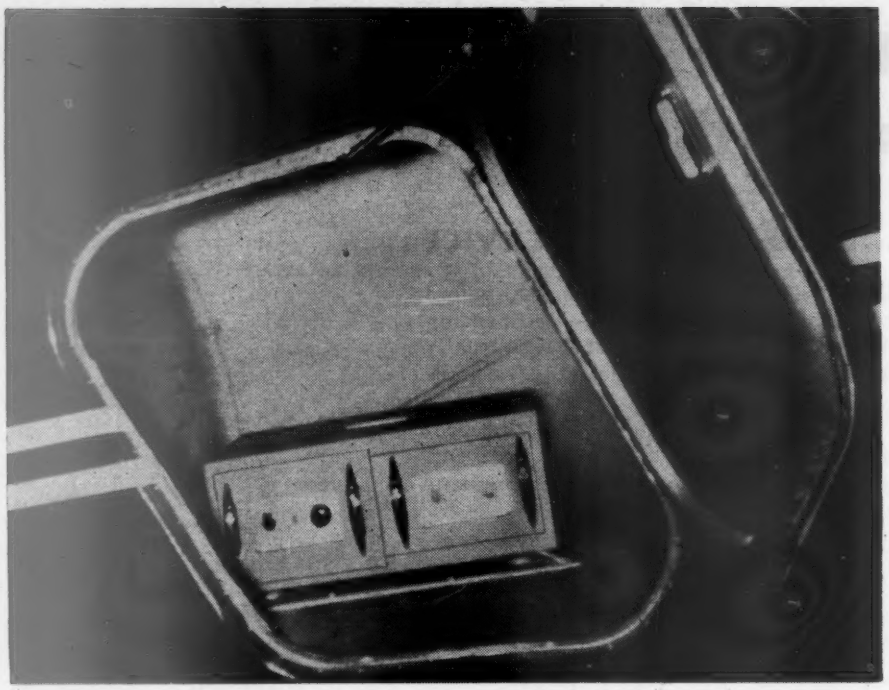
VALVES • FITTINGS • PIPE • PLUMBING AND HEATING



Two-way FM mobile radio equipment compactly mounted in fuselage of airplane. By means of radio, using two test cars and a plane, a highly efficient communications network can move rapidly over the line as tests are made.

Use of Radiotelephone in Pipe Line Construction

A NEW and economic application of two-way FM mobile radiotelephone for use in the construction and testing of gas pipe lines, was recently put into practice by Ford, Bacon and Davis, Inc., during the building of a pipe line for the Michigan-Wisconsin Pipe Line Company, which will supply natural gas from Texas to Michigan and Wisconsin.

This unique use of 2-way radio communication, which directly controls the cleaning and testing operations of newly laid pipe, has been made possible by the installation of a "three-point" radio network of FM mobile equipment.* Unlike most standard two-way radio systems, this equipment operates in a mobile-to-mobile hookup by using two radio-equipped vehicles as mobile "ground stations" and an airplane flying over the pipe line acting as the "central station".

*Manufactured by Federal Telephone and Radio Corporation, Clifton, New Jersey, associate of International Telephone and Telegraph Corporation.

As the cleaning and testing activities of a new pipe line are carried out, the air-to-ground mobile communication system becomes the key to safer, faster and more efficient operations.

Mainly responsible for the success of this efficient radio system is the airplane, which can fly over the route as rapidly as is required to keep a visual check from the air and make the necessary reports to the ground stations. Because FM radio permits only a line-of-sight transmission, the airplane is always in a position while in flight to be within line-of-sight of the mobile ground units, and thus provides efficient intelligence at maximum distances.

As lengths of pipe line are completed, high-pressure tests must be made to insure that all fittings and welded joints can stand up under the actual gas pressure to be applied later when the natural gas is pumped through.

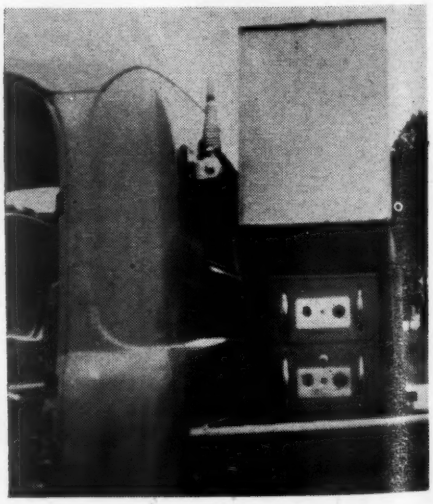
The "central station" radio equipment is mounted in the fuselage of a Stinson Voyager plane, with the FTR radio control unit mounted on the dashboard in the cockpit. From this position the pilot can visually survey the ground below and give out information via the radio system. The other two FTR mobile units are installed in vehicles situated at each end of the section of pipe line being tested. As the "pig" is forced through the pipe, the airplane travels low over the line in the same direction as the "pig" and consequently all three radio positions can move along the route as the operation is extended from one length of pipe line to another.

If anything should occur—such as an occasional break in the pipe, a fire, or any other unusual condition that can be seen from the air—the ground test positions are notified via the plane's radio. Instructions can be given to close valves, increase or decrease pressure, or any other information pertinent to providing safer, faster, and more efficient test operations.

By the ingenious use of a plane equipped with mobile radiotelephone, direct communication with all parties concerned is constantly maintained and it is no longer necessary for a truck or car to travel over the section of line under test to check on the physical results. Consequently much time is saved, property adjacent to the right-of-way is not interfered with, and the overall efficiency of the test procedure guarantees greater safety.

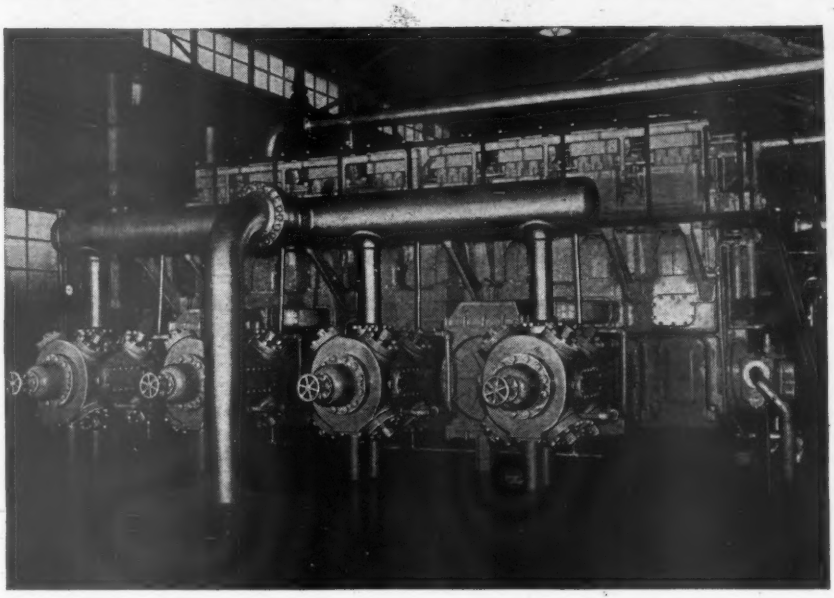
* * *

Car of Michigan-Wisconsin Pipe Line Company, which acts as "central station" in pipe line testing operations, is equipped with two-way FM mobile radiotelephone. While a plane flies overhead, also equipped with radio, two cars are used as "ground stations" in a three-point communications hookup.



PIPELINE OFFICIALS GATHER TO SEE REVOLUTIONARY NEW ANGLE GAS ENGINE COMPRESSOR

Tennessee Gas Transmission Company's New Worthington Uniflo TYPE UTC-16 Draws Visitors From Near And Far



The Tennessee Gas Transmission Company's new Worthington Angle Gas Engine Compressor — uniflo TYPE UTC-16 — installed at Monroe, La. The Company's natural gas pipeline will reach Buffalo, N. Y., and further extension is planned.

So widespread was the interest in Worthington's new Angle Gas Engine Compressor, TYPE UTC-16, that engineers and other executives from transmission companies all over the country came to see the first of these units in actual service — at the Tennessee Gas Transmission Company's Monroe, La., plant.

Advance notices of outstanding performance were fully lived up to, observers being particularly enthusiastic over the new uniflo scavenging. This radical improvement over conventional loop design provides more than double the port area and 50% more exhaust area. Straight-line air flow thoroughly cleanses and cools the entire cylinder, and timed valves retain greater weight of pure air for perfect combustion and stepped-up supercharging.

Features For Top Performance

En bloc frame, with removable cylinder liners . . . double air manifolds . . . completely symmetrical outer piston walls, wrist-pin in separate carrier . . . cone-type cylinder head, with streamlined passages and two large exhaust valves gear driven camshafts for positive drive and perfect timing . . . positive pressure lubrication through cast-in manifolds to all moving parts . . . large access doors on both sides of frame for complete accessibility . . . Worthington Feather* Valves, most efficient ever made, in all cylinders.

Wide Usefulness

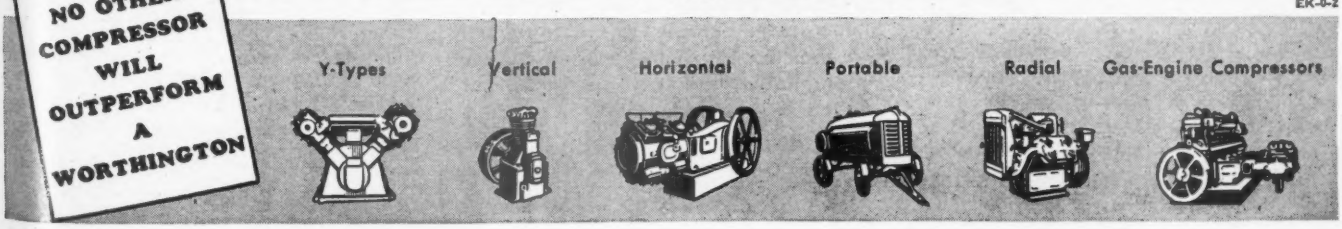
On pipeline duty, in refinery service— in fact, wherever gas must be compressed and suitable gas fuel is available — the uniflo TYPE UTC-16 offers dependability and economy never before possible . . . proof that, as always, *there's more worth in Worthington.* Learn more about this outstanding advancement in angle gas engine compressors Contact your nearest Worthington Branch Office or the *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

*Reg. U. S. Pat. Off.

EK-0-2

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



Jacket water surge tank, mufflers, and air cleaners.

Kit Carson Station

HAROLD F. DAWE* and HENRY N. WADE*

PART 2—Conclusion

Electrical power is generated for the station power and light requirements by three 8-cylinder, angle type, 370-bhp, 400-rpm, 4-cycle, gas engines driving three 250-kw, 0.8-pf, 480-volt, 3-phase, 60-cycle, 400-rpm generators with belt-driven 7½-kw top-mounted exciters.

The generators feed into a three-generator panel control board. The generators have automatic synchronizing relays. One refinement is a Var-meter on each generator panel, which discloses to the operator the actual lagging or leading component of the power from each generator. In other words, this instrument measures directly the true reactive power. Its use makes it easier to divide the load equally between the generators.

The switchboard is enclosed and is completely protected. A cable vault covered by checkered floor plate is provided at the rear of the switchboard for ease in installation and maintenance. All wire is laid in troughs.

Pushbutton stations are provided at all motors; all starters are in the main panelboard. Extensive studies indicated this arrangement to be the most economical. All electric wiring is underground in galvanized conduit, and distribution is made through cable vaults. The compressor and meter buildings are provided with explosion-proof electrical equipment for power and lights. In other buildings electrical equipment is conventional.

The lighting is designed for a high illumination level, and special attention has been given to provide adequate lighting for all outside equipment. Electrical energy for the 6-house camp is provided through a 480-volt underground and overhead system to the camp area, with step-down transformers at the camp.

Engine Ignition System

Engine ignition is the direct-current-impulse type with individual induction coils for each spark-plug. Each engine has a dual ignition system for the 6 cylinders. Instead of the conventional magneto source of power to the ignition coils, there is an individual d-c rectifier of the copper oxide type for each engine. These units are supplied from the 440-volt, 3-phase, 60-cycle main power source. They have their own built-in transformers, and provide a practically rippleless 10-14-volt, 2-to-4 amp direct current to supply the ignition demands of each engine. Each unit has its own volt- and ampere meter, built-in circuit breaker, and rheostat for varying the voltage as required. There are no batteries in the ignition system.

This system of ignition was developed sometime ago and has been thoroughly tested under actual operating conditions by engine manufacturers and pipe line operators. It provides an exceptionally clean and trouble-free source of direct current.

One distinct advantage of this system is that it provides a fool-proof interlock between the station electric generators, water circulating pumps, and engines. If the main electric power fails for any reason the water circulating pumps on the jacket water system, being electric-driven, necessarily shut down. As the compressor ignition system will also shut down upon a power failure, the compressors are stopped at once, making it impossible for them to become overheated by running after failure of the jacket water circulation.

Another advantage lies in the fact that each machine has its own individual rectifier unit and is, therefore, independent of all the other machines. Thus the entire station cannot be shut down through failure of an element of the ignition as can occur where a central battery-and-charger system is used.

Finally, the system is actually cheaper to install and much cheaper to maintain than either individual magnetos or a central battery-and-charger.

Fuel Gas System

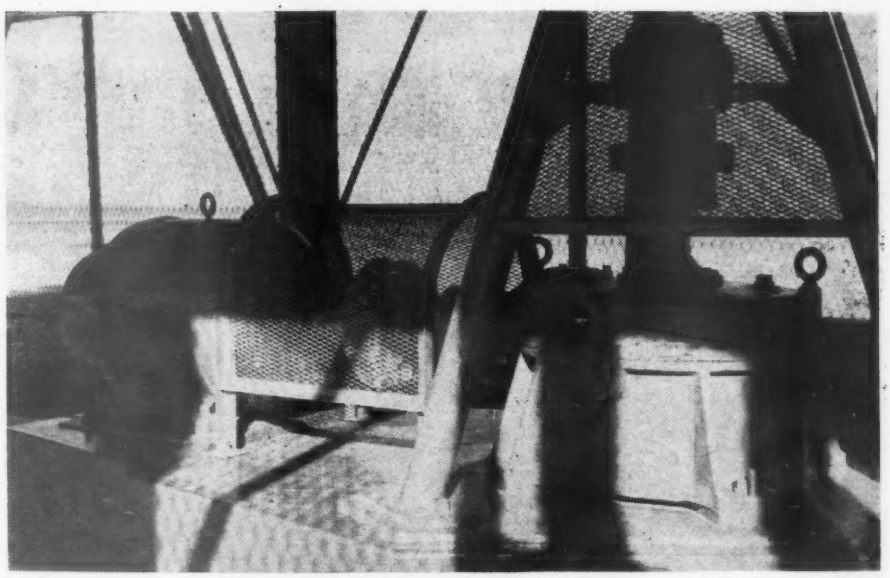
Fuel gas for the station is dehydrated gas from the main pipe line, which may be taken from either the suction or discharge side. Fuel gas is metered through two 6-in. metering runs in the meter building. The gas is reduced from a maximum of 900 psig to metering pressure of 25 psig through a double-ported pilot-operated regulator installed in each run. In order to avoid difficulty due to possible hydrate formation, the fuel gas is passed through a finned tube heater ahead of the regulators. The heater is supplied with jacket water from the hot jacket system and use is made of the same water to heat the meter building through electric fan-blown unit heaters.

The compressor engines utilize the fuel gas at 25 psig, and no individual engine regulators are used. The fuel

*The Stearns-Roger Manufacturing Company.

EXCLUSIVE

Fan drive showing hydraulic coupling between gear box and motor.



gas header for the compressors is placed in the compressor room basement. The fuel gas for the generators and boiler is reduced from 25 to 1 psig in a dual setting of pressure-balanced pressure regulators. Utility gas to the plant offices, buildings, and camp is distributed at 25-psig pressure. The gas to the camp is odorized.

The emergency system for shutdown includes an emergency shutdown station placed at each end of the compressor building, at the generator building, and at the office. Operating any station will close the automatic inlet and outlet main valves to the station and will cut out the rectifier ignition systems to the compressor engines, effectively stopping all gas compression. It also vents all gas in the fuel system.

Lubricating Oil System

A complete fresh oil supply and used oil reclaiming system is provided. A 10-ft by 20-ft horizontal tank holds the supply of fresh oil. Two small positive displacement pumps take suction from this tank and discharge into a pressure tank in the auxiliary building. This tank is equipped with a pressure control switch to automatically start and stop the pumps, assuring a fresh oil supply under pressure at all times. Oil is supplied from this tank to dispenser sinks, one in the auxiliary building and two in the compressor building. Fresh oil is metered through displacement meters at each dispenser, allowing a constant check on the fresh oil consumed. Lubricating oil lines run from the meters to each engine, so that it is a simple procedure to fill lubricators or engine crankcase without manually carrying oil to the machines.

Two oil reclaimers are installed in the compressor building. Each has a capacity of 500 gal each 24 hr. One reclaimer handles oil from three compressor units, and one from four. The three electric generator engines have a separate oil reclaimer. Positive control over the oil being reclaimed from each engine is possible through the use of interlinked three-way valves so arranged that the oil being reclaimed is returned to the engine being serviced.

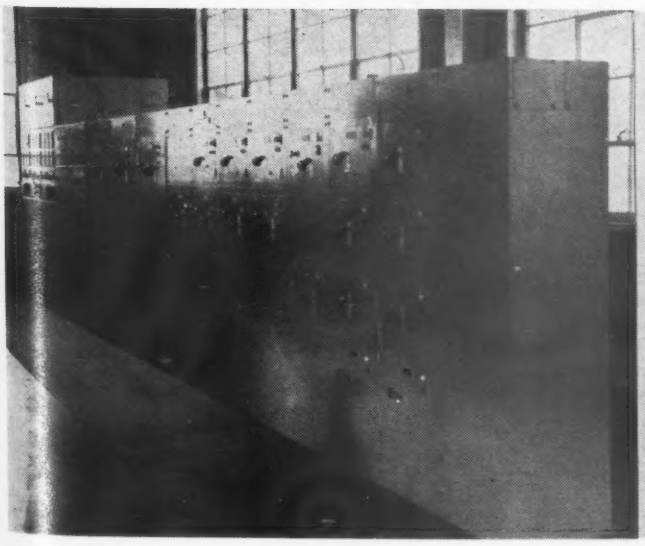
Two dirty oil tanks are provided; one in each end of the compressor building to collect oil drained from an engine. A dirty oil pump handles oil drained from the generators to the dirty oil tanks. The oil reclaimers are arranged so that any oil in the dirty oil tanks may be purified and sent to reclaimed oil tanks, one in each end of compressor room and one in the generator room. Reclaimed oil from these tanks is used entirely as makeup. It is piped to a second dispenser nozzle situated at each dispenser sink. This oil is not metered. Oil is drained from the piston rod and packing gland drains to the dirty oil tanks where it is stored for future purification. Gas from the packing gland vents is piped to a trap at each compressor engine where the gas is released and the oil collected.

Communications Systems

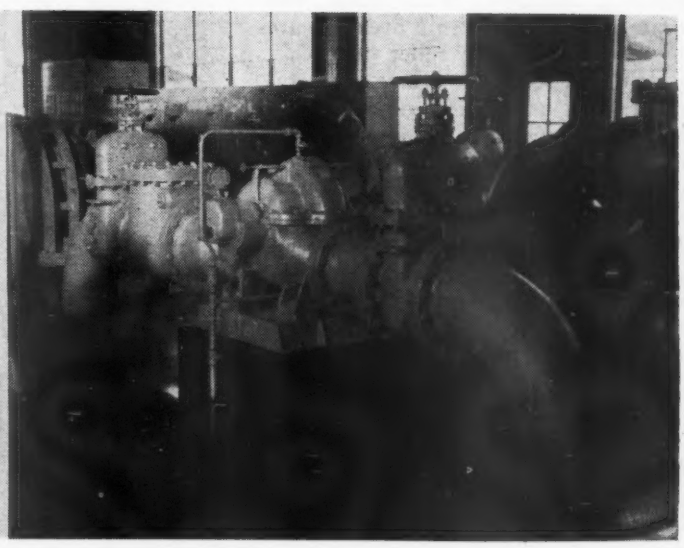
A telephone system has been installed connecting the generator building, the office, and the camp, utilizing a switchboard in the office. A company telephone line also connects the station with the company dispatcher at Colorado Springs.

A frequency-modulation radio sys-

Generator control panels and switchboard.



Hot jacket water pumps.



Fuel gas preheater coil before metering.

Lube oil pressure pumps and air compressors.

tem is provided, the station dispatcher acting as operator. The transmitting tower for this is situated on the station site and key company cars and trucks are radio equipped. Future radio installations of the same type will allow communication with the company main office.

Station pressure reports are transmitted automatically to the central dispatcher in Colorado Springs.

Dust Scrubbers

The 20-in. inlet gas line to the station is piped into a manifold connected into two dust scrubbers. Each scrubber has a capacity of 122,500,000 cu ft of gas at 565 psia pressure and is 60 in. in diam by 24½ ft high. These are so sized that future scrubbers will not be required. Each scrubber has large cleanout manholes in the base. The units are protected from overpressure by means of a safety relief valve.

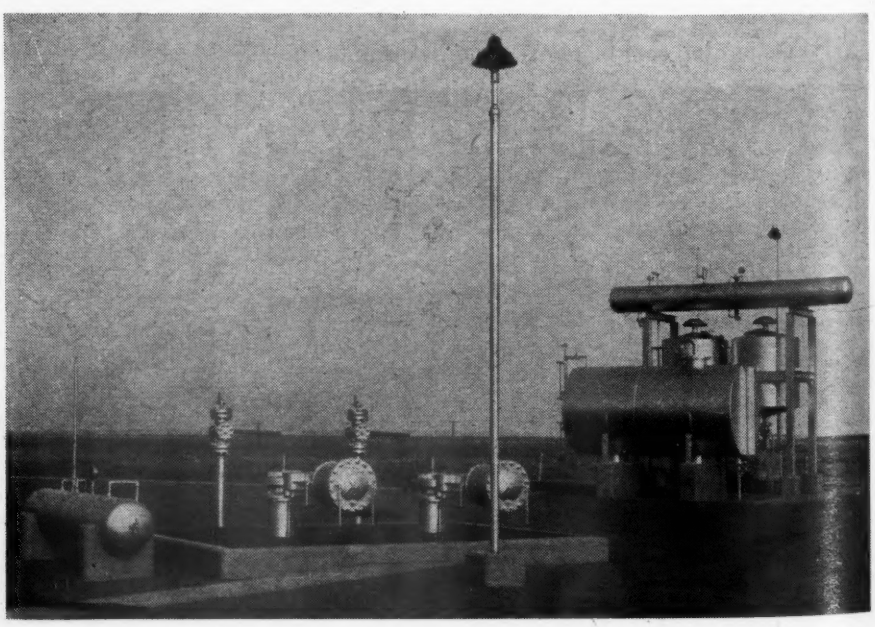
The dust scrubbers are of a general design that has proved most effective in previous installations on major gas lines. The scrubbing efficiency is extremely high and the oil carryover is negligible. These scrubbers have an automatic level control device that corrects for varying rates of flow without the attention of an operator. This feature has proved most valuable in pipe line installations. Each unit is provided with ample capacity in the base for settling solids and accumulating entrained hydrocarbon liquid that may come through the line. The liquid level in each scrubber is controlled automatically through a liquid level controller.

A scrubber oil charging tank and two scrubber oil settling tanks are installed. The scrubber oil charging tank is built for the same pressure as the scrubbers, and is elevated a few feet. After being filled with oil, the tank is equalized to the scrubber pressure, allowing the oil to gravitate into the scrubber. The scrubbers are blown down into the settling tank where the oil-entrained dust is allowed to settle out and the scrubber oil drawn off for re-use.

A 6-ft diam by 12-ft long horizontal storage tank has been installed for scrubber oil storage. Scrubber oil is moved from this tank to the scrubbers or charging tank by means of a motor-driven positive displacement pump.

Piping Design

Standards of the American Standard Association Code for Pressure Piping were used in the design of the piping. Section 3 of this standard covering oil and gas piping inside refinery limits was used. Although the



Automatic station valves with scrubber oil storage and settling tanks in background.

Aldrich-Groff Constant Stroke Pump, used in conjunction with the Variable Stroke "POWR-SAVR" to provide the desired base volume of delivery.

Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump, applicable throughout the Petroleum Industry, is available in 6 frame sizes ranging from 5 to 125 hp for pressures from 250 to 15,000 psi, and provides step-less, automatic control of delivery.

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Maintain Maximum Pipe Line Efficiency...

By combining an Aldrich-Groff Variable Stroke "POWR-SAVR" Pump with either its companion Aldrich-Groff Constant Stroke Triplex Units or an Aldrich Multuplex Pump, you can automatically eliminate line pressure swing and safely maintain the maximum rate of delivery in your line at all times. You can also simplify pump station control and eliminate the expense and objectionable features of station surge tanks.

The development of Aldrich-Groff Variable Stroke and Constant Stroke Pumps—to embody *interchangeable fluid-end* and *principal power-end parts* — constituted another notable Aldrich "First". These units are serving on a number of modern high pressure pipe lines with the satisfactory results indicated by repeat orders.

Variable Stroke Pumping Capacity need only cover throughput variations incident to temperature and viscosity changes. The bulk of the installed capacity may be of the less expensive Constant Stroke Units. Such a multiple unit installation not only affords pumping flexibility and extreme reliability, but also lessens the investment for spare unit capacity. And, pumping units need only be installed to care for initial line capacity with additional units being added as the line demands build up. This means less initial investment expense and attainment of full load efficiency under all conditions, with consequent savings in pumping power.

Both types of units employ a *conventional fixed throw crankshaft* of solid forged steel construction which has proven to be best adapted for reliable continuous service, as attested by over 500 units installed so far—many with 10 year service records.

Both units feature self-contained reduction gear drive adapted to utilize an efficient high speed motor or turbine (for refinery service) mounted on the pump frame itself. This not only means compactness of floor space and savings in foundation and building costs—but assures accurate mechanical alignment at all times. V-Belt and other forms of engine drive are optional.

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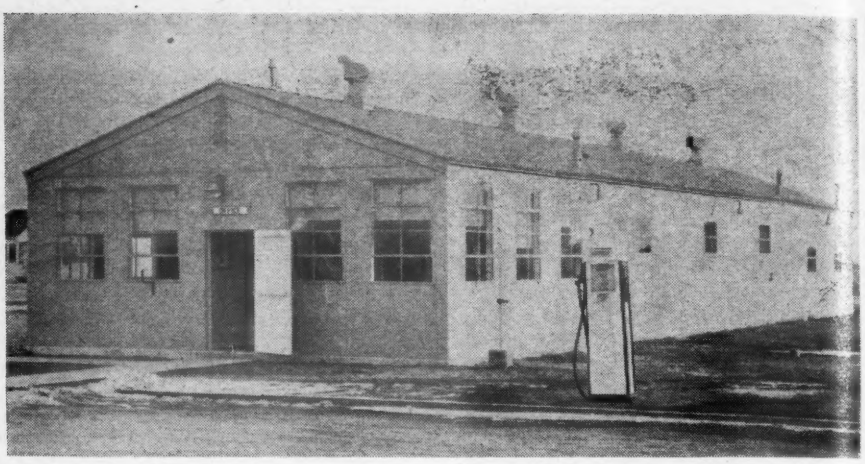
standards covering cross country pipe lines and compressor stations according to Section 2, Division 2 of the Piping Code could have been used, the engineers responsible for the design felt that this standard is not adequate for safe application to piping in such plants. Extensive experience in the design and operation of compressor plants indicates that the more rigid requirements of Section 3 of the Code are advisable on account of the concentrated risk to equipment and personnel. In this station, these standards were observed to points about 75 ft outside all active plant boundaries.

Buildings

Buildings in general were custom-built for the installation, except the office, warehouse, and garage, which is a 28-ft by 100-ft prefabricated steel building.

The buildings, other than the one steel building, are structural steel-frames covered with corrugated cement-asbestos board. These have full ridge vents with dampers and the compressor building has a double row of windows. Windows in all cases are large and set near the floor line to give exceptionally good light and ventilation.

The compressor and auxiliary buildings are each provided with 4-ton bridge type cranes. The auxiliary building is extended to provide a large shop section where general repairs are handled. The building is also divided by partitions to provide a smoking room and change room for the station personnel.



Office building.

The auxiliary, machine shop building, and office have the required sanitary facilities. Electric drinking water fountains are also provided in all buildings. The station has a complete sewerage system including septic tanks and tile fields.

The main buildings are heated by low pressure steam supplied by a 15-psig gas-fired steam boiler installed in the auxiliary building. The steam is transmitted through underground steam mains to the buildings where it supplies blower type unit heaters; the condensate formed is returned to the boiler through a condensate return and water makeup unit. The garage, office, and warehouse building is heated by direct gas-fired unit heaters.

All buildings except the garage, office, and warehouse are painted in colors that have been chosen for their psychological effect. The color harmonic scheme results in an overall effect that is at once pleasant and restful. The buildings lack any feeling of close confinement, such as is sometimes associated with industrial interiors.

Camp

A 6-house camp has been installed. All camp buildings are custom-built. The houses all have five rooms with laundry and storage space. Two-car garages are provided—one for each two houses.

Complete utilities including gas, water, lights, and sewerage are provided for all houses. A 20,000-gal double ellipsoidal all-welded steel water storage tank 60 ft high provides adequate water under pressure for all domestic uses, and serves to supplement the 1000-bbl main storage tank on the ground. Two 100-gal per min pumps are installed in the auxiliary building to supply water to the elevated tank. These also serve to supply water under pressure to the fire hydrants in the station and camp.

The compressor station was designed and constructed by the Stearns-Roger Manufacturing Company in cooperation with the engineers of the Colorado Interstate Gas Company. The camp was constructed by the Colorado Interstate Gas Company.

* * *

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SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

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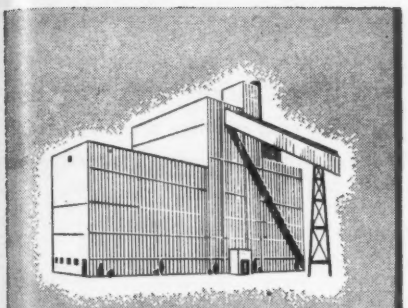
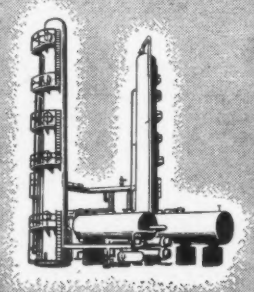


POWER DIVISION



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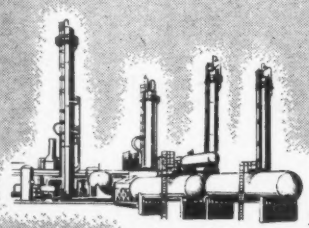

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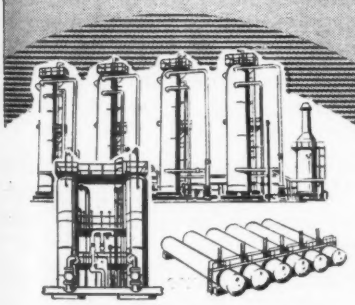

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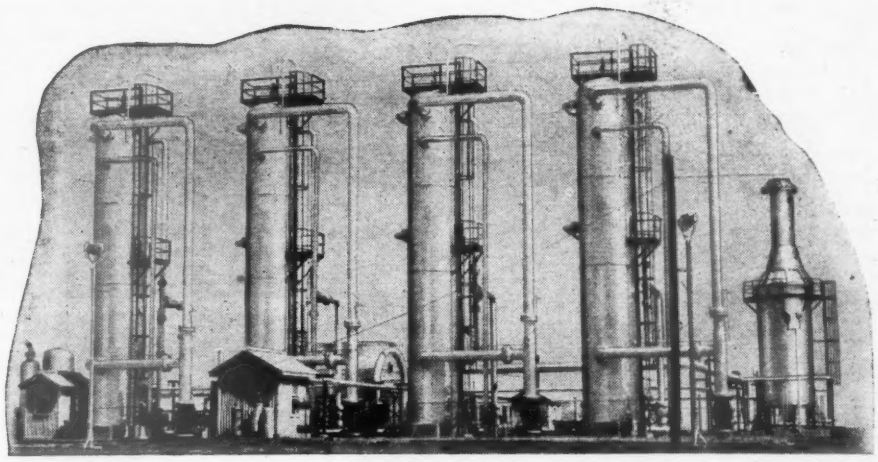

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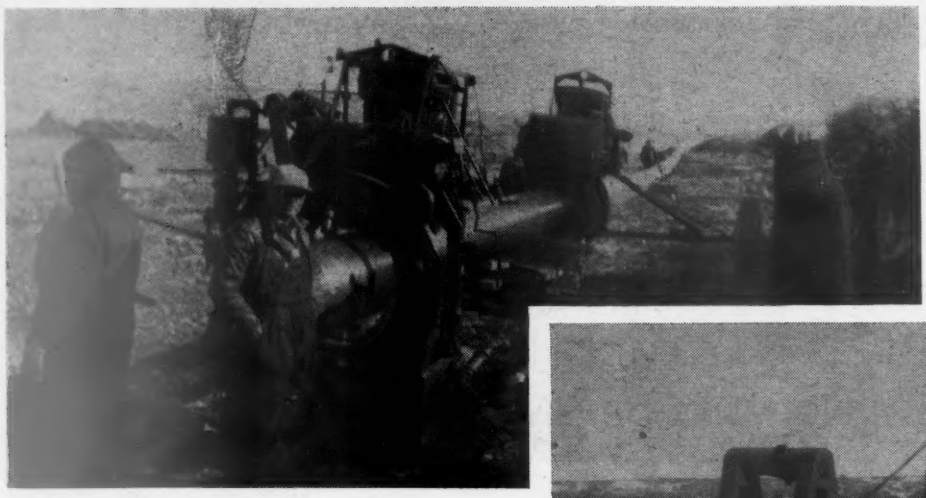

Heavy equipment such as these cleaning and coating machines, bulldozers, and sideboom tractors were used on the surface of the frozen river.

By LESLIE O. ROWLAND

River Crossing Comes to Grief

A RIVER crossing job that came to grief through bad weather conditions has delayed construction of the biggest under-water link in the Interprovincial Pipe Line Company line from Edmonton, Alberta to Superior, Wisconsin. The 3500-ft crossing of the South Saskatchewan River between Outlook and Macrorie, Saskatchewan, was abandoned after four cats in a row had plunged through softening ice on the frozen river surface into 5 or 6 ft of water.

The Outlook crossing was plagued by severe weather from its beginning early in February. The plan of the work was to ditch through the ice and 7 ft into the river bed, using backhoes across the ice and draglines up the banks, which at the point chosen for the crossing presented a fairly gentle gradient of less than 30 deg. Pipe used is 20-in. steel, ½-in. thick, from the A. O. Smith Corporation mill in Milwaukee. Ditching was completed through the river ice by early in March, but a sudden thaw caused swelling and overflow that forced withdrawal of equipment. Before it could be placed in operation again the channel was frozen over, requiring a second ice cutting job.

The work was further complicated by large solidly frozen gravel bars on the river bottom. Being a prairie river, the Saskatchewan is inclined to change its course frequently and these bars are built up usually during the spring floods. Dynamiting was resorted to on a generous scale to remove these obstacles to ditching, but the blasting tended to weaken and shatter the ice. Coupled with delays due to severe blizzards and a two-day sand storm, this resulted in not having the pipe strung across the ice and welding completed until after the middle of March, suffering risk of ice collapse. Coating with "Bitumastic" 70-B enamel and wrapping had proceeded to about half the distance across the river when the four leading sideboom cats fell through the weakened ice in succession. This followed two days of sudden thawing. It was then decided to withdraw all equipment from the ice. A relay of five large cats was hitched up on the east bank and the entire 3500-ft length of pipe, weighing about 185 tons, was pulled back onto the shore.

Contractors have since loaded all their equipment onto flat cars for shipment to other work points along the landward part of the line, and a new engineering plan will have to be drawn up for stringing the pipe across the river after the ice goes out in the spring. Normally the break-up season may last as long as six or eight weeks. Owing to the strong current and possibility of shifting of the river bed to some extent, a bow of about 500 ft in the 3500 was allowed for in ditching the river bed and in assembling the pipe.

Two other river crossings, of 1200 and 1400 ft respectively, have been finished through the ice without interruption.

Weighting is done with concrete blocks made up like split collars and placed in pairs every 20 ft, i.e. two to each 40-ft joint. For the long Outlook crossing these were designed to weigh 1900 lb a pair, thus doubling the normal two-ton weight of each joint. On the shorter crossings weight is 1200 lb a pair. Block valves are being installed at both sides of each river crossing.

Contractor on this section of the line is Bechtel-Mannix, with sub-contractor for the crossing job Sparling-Davis of Edmonton. "Cowboy" Pollard was Interprovincial inspector for the job, Vic Williams was in charge for Sparling-Davis and supervised the later and more critical part of the work. * * *

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Now! a FASTER·EASIER·SAFER way to handle pipe

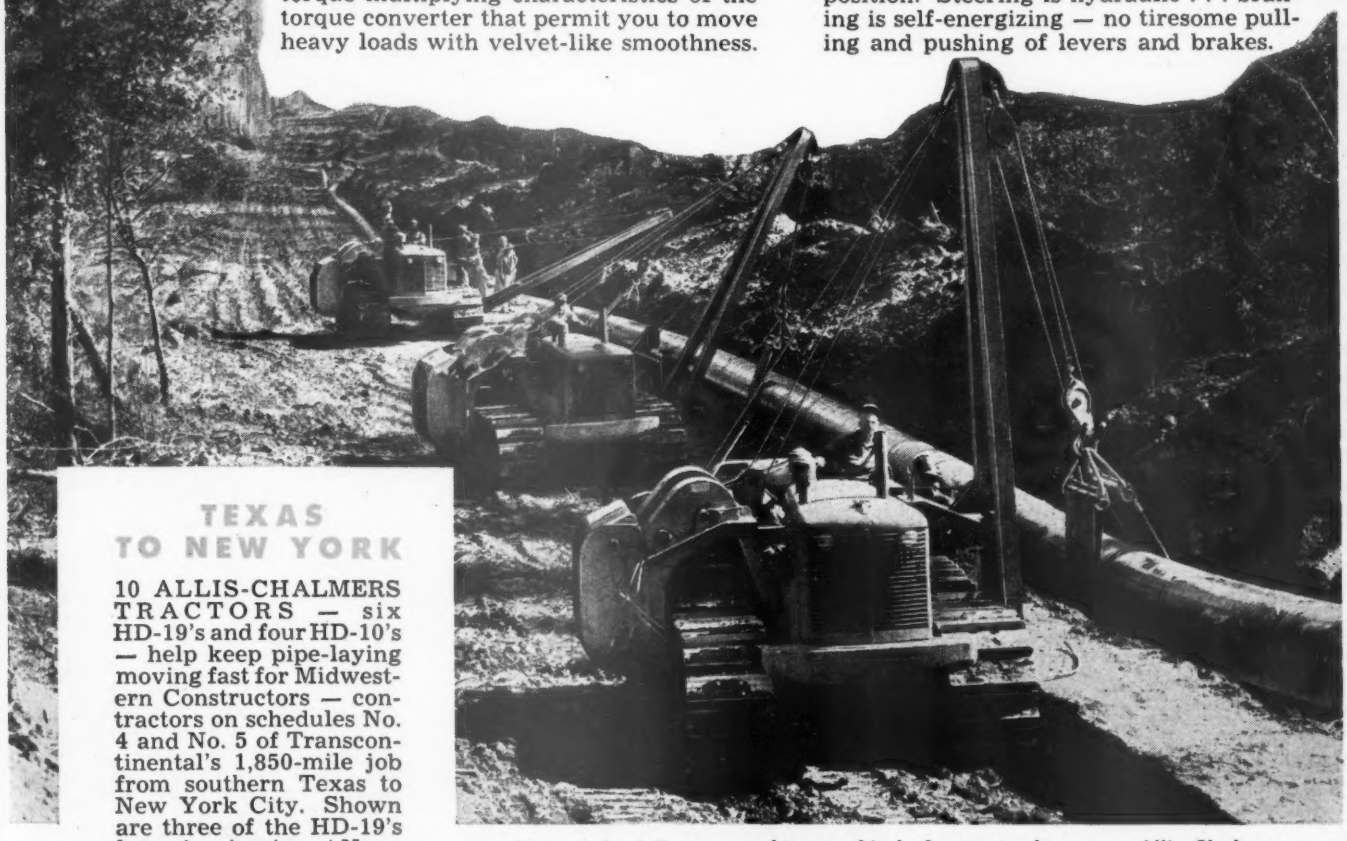
WORLD'S LARGEST TRACTOR—Allis-Chalmers HD-19 with Hydraulic Torque Converter Drive — Brings You a New Kind of Performance On All Phases of Pipe-line Work.

GREAT LIFTING CAPACITY A big, powerful tractor with 40,000 lbs. of properly balanced weight, the HD-19 easily handles the largest, heaviest pipe. With boom low, it can lower-in pipe from a position of 10 to 12 feet from edge of trench . . . thus prevents cave-ins. Also, torque converter drive assures smooth, easy, safe lowering — no sudden jerking or jarring.

UNUSUAL FLOTATION ABILITY Creeps along over soft going...doesn't dig itself in or get hung up on stumps. Has unusual high clearance and long, 28-inch, extra wide, sure-gripping tracks . . . plus the torque multiplying characteristics of the torque converter that permit you to move heavy loads with velvet-like smoothness.

OUTPERFORMS IN ANY GOING Easily pulls heavy equipment — like bending machines — up steep grades and through soft going. The torque converter drive automatically synchronizes HD-19's speed with the equipment being pulled or pushed — no shifting. An important advantage when working with cleaning and priming or doping and wrapping machines!

OUTMANEUVERS Shifting is practically eliminated — only two forward gear ratios — 0 to 3 and 0 to 7 m.p.h. Operator just "guns" the throttle when pipe is lowered-in, gets in front of other tractors in a hurry and quickly maneuvers into position. Steering is hydraulic . . . braking is self-energizing — no tiresome pulling and pushing of levers and brakes.



TEXAS TO NEW YORK

10 ALLIS-CHALMERS TRACTORS — six HD-19's and four HD-10's — help keep pipe-laying moving fast for Midwestern Constructors — contractors on schedules No. 4 and No. 5 of Transcontinental's 1,850-mile job from southern Texas to New York City. Shown are three of the HD-19's lowering-in pipe at Newnan, Georgia.

But get the full story on this new kind of a tractor from your Allis-Chalmers dealer. Let him give you a demonstration. "Seeing Is Believing."

There's a right size A-C tractor for every need

Model	Horsepower	Weight (bare)
HD-19	163.00 on flywheel	40,000 lbs.
HD-10	86.63 drawbar	21,000 lbs.
HD-7	60.10 drawbar	13,830 lbs.
HD-5	40.26 drawbar	10,500 lbs.

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NEWS

Pipe Line Case Goes Directly to Commission

The Federal Power Commission has ordered intermediate decision procedure omitted in the proceeding involving Texas Illinois Natural Gas Pipeline Company's application for authorization to build a Texas-to-Illinois natural gas pipeline project.

The action, requested by the company, means that the case will now go directly to the Commission for decision without the filing of an intermediate decision by the presiding examiner. Public hearing on the application was concluded April 28.

Texas Illinois, which has its main office in Chicago, Illinois, is proposing to build a 1134-mile main line, at an estimated cost of $117,070,000 to carry natural gas to markets in the Midwest, including Illinois, Indiana, and Iowa.

Tennessee Gas Will Construct Extraction Plant

The Tennessee Gas Transmission Company will construct and operate a $12,000,000 extraction and recovery plant adjacent to its natural gas pipe line system near Greensburg, Kentucky, it is announced by Gardiner Symonds, president.

The plant will process a substantial portion of the natural gas passing through the company's pipe line system at that point. It will be designed to process initially in excess of 600,000,000 cu ft of gas daily from which will be obtained approximately 400,000 gal of liquid hydrocarbons consisting of ethane, propane, butane, and natural gasoline.

The liquid hydrocarbon stream will be sold to the newly-formed Mathieson Hydrocarbon Chemical Corporation, a $27,000,000 joint venture of the Mathieson Chemical Corporation of Baltimore, Maryland, and the shareholders of the Tennessee Gas Transmission Company of Houston, Texas. An 8-in. pipe line will be built to transport the liquid hydrocarbon stream from the extraction plant to a new chemical plant to be built by the Mathieson Hydrocarbon Chemical Corporation on the Ohio River near Brandenburg, Kentucky. The chemical plant will further process the hydrocarbon stream.

It is anticipated that construction will begin within approximately two months and that the plant will begin operation in the summer of 1951. A low temperature separation process will be utilized in the stripping plant.

FPC Denies Request to Purchase Pipe Line Facilities

The Federal Power Commission has issued an opinion and order denying a proposal for Northern Natural Gas Company to acquire and operate, and for Independent Natural Gas Company to abandon and sell, a compressor station in Gray County, Texas, and a 21-mile pipe line extending from the station to a connection with Northern's facilities in Carson County, Texas.

The proposed transaction would have permitted Northern to purchase gas directly from Phillips Petroleum Company.

In denying the joint application, the Commission pointed out that the proposed contract under which Northern would purchase gas from Phillips would increase the cost of gas to Northern by $150,000 a year. Other expenses that would devolve upon Northern, FPC said, are compressor station fuel costs and expenses estimated to be $371,000.

The Commission noted that in addition to the $229,200 that Northern proposed to pay for the compressor station and line, it also planned to rehabilitate the facilities at a cost of $211,000, and that the annual expense on this plant investment will total $66,000.

The total increased expense to Northern, FPC said, would be $587,000 per year, or a total of about $3,180,000 between now and October 1, 1955, the end of the present contract period with Independent. The Commission said that this "appears to be an excessive and unreasonable charge for a 10-year extension of the present contract."

J. P. Bristow Opens Consulting Office

J. P. Bristow and Company is a new firm of engineers and consultants that has opened offices in the City National Bank Building, Houston, Texas. The company will specialize in reports, appraisals, and design of pipe lines, plants, and distribution systems. J. P. Bristow has been vice president of the Tennessee Gas Transmission Company.

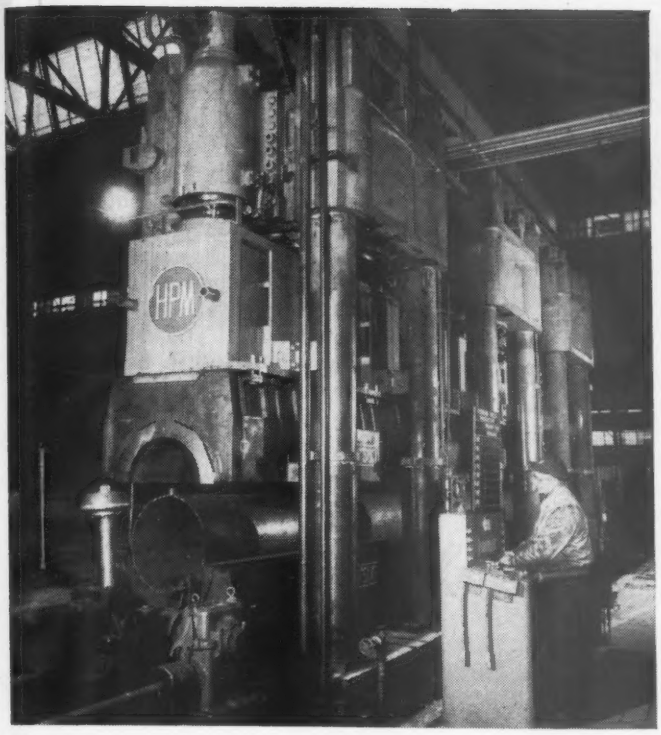
High Precision Gear Speed Increasers Shipped

The first shipment of high precision gear speed increasing units designed and built by Western Gear Works, Lynwood, California, for use on a Texas to Ohio pipe line, was made last month. Shown in the accompanying photograph holding the sign is B. A. Bannan, left, the company's vice president and

general manager, and B. J. Bannan, plant manager. The units are being built in 1200 and 1700-hp sizes to transmit power from diesel engines to high speed multi-stage centrifugal pumps, multiplying the engine speed by a ratio of 8:1 up to 10:1.

The high operating pitch-line velocity of these gears, greater than 10,000 rpm, in combination with the necessity for long trouble-free life in 24-hr per day service, as well as smooth, quiet operation, demands the finest degree of precision possible in modern gear manufacturing methods and machine tools.

Western Gear Works operates plants in Lynwood (Los Angeles County), San Francisco, Seattle, and Houston, Texas.



Large diameter pipe for gas transmission lines is pressed into shape in this 18,000-ton hydraulic machine in the new electric welded pipe mill of U. S. Steel's National Tube Company at McKeesport, Pennsylvania.

R. L. Jaeger (far left), chief engineer for Gaso Pump, and Royce Coffin, Capt. Mason, a visiting officer; Lowell Anderson, Lloyd Roberts, H. A. Wienecke, sales engineer, Gaso Pump; George Kimes, company commander; William Clark, Jackson Behling, and George Tongue, Jr.

National Tube Makes Large Diameter Pipe

A new mill of U. S. Steel's National Tube Company at McKeesport, Pennsylvania, has begun making pipe large enough to deliver 344,000,000 cu ft of gas every 24 hr.

The mill at National Works is geared to turn out annually 100,000 tons of electric welded and hydraulically expanded steel pipe, ranging up to 36 in. in diam. Initial production is on an order for 30-in. size.

Manufacture of pipe this large is new in Pittsburgh steelmaking trends since the war's end, and is an indication of the move toward increased use of gas for industrial use and home heating throughout the country.

Sixteen big new machines are the major units of the mill, which convert wide, flat lengths of steel plate into welded pipe. The mill is expected to reach a normal production pace the early part of July, when its crew will be able to turn out a section of pipe 40-ft long every five minutes.

The new facilities make up a compact, streamlined production unit, involving the use of roller conveyors to move the heavy steel pieces of semi-finished pipe from machine to machine, much like the assembly-line operation in automobile plants.

Among the major units in the production line are a 2000-ton hydraulic press, identified as a U-ing press because it forms the steel plate into a U shape, and an 18,000-ton hydraulic press that forms the U-shaped piece into its finished round shape.

Steel plates are shipped to the plant from the rolling mills at Homestead Works of Carnegie Illinois Steel, another U. S. Steel subsidiary. The mill can handle sizes ranging from 78½ to 110 in. wide, 40 ft long, and from ¼ to ½ in. in thickness.

Pipe Line Supply Unit Takes Intensive Training

The U. S. Army's specialist training program, performed in affiliation with industry, is gaining effective results with the 808th Engineer Petroleum Distribution Company. This organization, the first in Oklahoma and sponsored by Service Pipe Line Company (formerly Stanolind Pipe Line Company) is virtually ready to take to the field as a pipe line petroleum supply unit for the armed forces in event of war. (See photo above right).

Activated in August, 1949, the unit has been taking intensive training. Training includes twice monthly lectures, and field trips every two months to industries related to pipelining. The unit will attend a training camp in Texas for two weeks this summer.

Captain George B. Kimes, commanding officer of the 808th Petroleum Distribution Company, gives most of the lectures. A member of the Service Pipe Line Company engineering department, Kimes was a chief instructor three years during the war at the corps of engineers pipe line school at Camp Claiborne, Louisiana, and Fort Lewis, Washington.

The unit's full strength at present is seven officers, but 12 enlisted men with the rank of sergeant will be added within the next two months. Service with the unit is voluntary. The seven officers form the nucleus of a military company that will be able to construct and operate two tank farms, 120 miles of pipe line in between, warehouses, and 12 pumping stations.

The unit was the first in Tulsa to be sponsored by a private organization under the Army's affiliated reserve unit program.

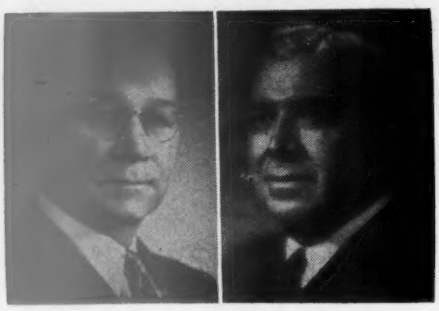
The affiliation program seeks specialists who can be organized into complete units. Affiliated units assure efficient and speedy utilization of technically qualified personnel on wartime assignments similar to those performed in civilian life.

Members of the 808th Petroleum Distribution Company are: Lts. Lloyd Roberts, Lowell Anderson, Jackson Behling, William Clark, George Tongue, Jr., Royce Coffin, and Capt. Kimes.

Pan American Pipe Line Names New Officers

In preparation for an expansion of its trunk line and field gathering systems to serve West Texas oil fields, Pan American Pipe Line Company recently named officers and members of its board of directors who will direct these and other future pipe line operations.

The company, which operates as a common carrier within the state of



P. J. Sweeny I. O. Walker

Texas, is now under the immediate control of its own officers and directors, no one of whom is an officer, director, or employe of any affiliated company. Home offices of the company are in the Esperson Building in Houston, Texas.

Perry J. Sweeny of Texas City, Texas, a prominent figure in the Southwestern petroleum industry, and also well known in business and banking circles, was elected chairman of the board. Ira O. Walker of Houston was named president. Their elevation to their present positions represents the culmination of successful and varied careers with companies of the Standard Oil Company (Indiana) group.

Other members of the board of directors of Pan American Pipe Line Company are J. W. Cable III, L. C. Dunbar, E. W. Krug, Herbert Thalheimer, and R. C. Wiles, who is vice president and treasurer of the company. H. R. Jones, of the Houston law firm of Andrews, Kurth, Campbell and Bradley, is counsel for the company as well as a member of the board.

Service Has New Savings And Stock Bonus Plan

J. L. Burke, president of Service Pipe Line Company, announces adoption of a new savings and stock bonus plan that will benefit the company's 2800 employes in ten states.

Burke said the plan will provide for the issuance of stock of Standard Oil Company (Indiana), its parent company, to employes who participate in the company's contributory retirement plan and buy United States Savings bonds under a payroll savings plan over a year's period.

The stock will be issued to participating employes without additional cost. The new plan will encourage employe savings as well as wider participation in the company's contributory retirement plan and at the same time it will increase employe interest in the welfare of the company, pipe line officials believe.

Employes can authorize the company to deduct from their pay for investment in U. S. Series E bonds as much as 4 per cent or as little as 2 per cent of what they earned the year before. Employes will receive the bonds as they pay for them. At the end of each plan year each participant will receive one share of stock for each "bonus unit" of payroll deductions that has been credited to him for bond purchase.

The bonus unit for each plan year will be equal, in round numbers, to one and one-half times the book value of a share of Standard Oil (Indiana) stock at the close of the preceding calendar year. Since the book value of a share at the end of 1949 was $70.88, the bonus unit for the first plan year will be $106.

Service Pipe Line Company is the former Stanolind Pipe Line Company, changing its name effective May 1.

Model Tests to be Run for Large Tankers

The Experimental Towing Tank at Stevens Institute of Technology will run self-propelled model tests for the two largest tankers ever to be built in Canada. To be owned by Pipe Line Tankers, Ltd., Toronto, the 620-ft ships will be chartered for a 15-year period to Imperial Oil, Ltd., of Canada for operation between Superior, Wisconsin, and Sarnia, Ontario, via Lake Superior and Lake Huron. They will carry oil brought by pipe line from Edmonton, Alberta, Canada, to Superior.

The giant tankers will be built by the Port Arthur Ship Building Company, Ltd., and the Collingwood Slip Yards, Ltd., and are expected to be ready early in 1951.

The ships will have a beam of 68 ft and depth of 35 ft, with a displacement of 21,560 tons. With a designed draft of 24 ft, each will carry 115,000 bbl of oil at a speed of 13 to 14 knots.

The self-propelled model is now being made ready for tests with two different designs of propellers. These tests will determine the usual propulsion characteristics, including horsepower, propulsion efficiency, wake fraction, thrust deduction, and propeller slip.

H. C. Price Awarded Major Contract by TGT

The H. C. Price Company has been awarded a contract by the Tennessee Gas Transmission Company to construct approximately 373 miles of an extension of TGT's main supply line from the Ohio River to Buffalo, New York.

The Price company's portion of this important 26-in. link in the rapidly expanding TGT system will commence on the north bank of the Ohio River near Portsmouth, Ohio, and stretch north and eastward to within a few miles of Buffalo. Slightly more than 200 miles of the Price job will be across the eastern half of Ohio, nearly 100 miles across the northwestern corner of Pennsylvania, and an additional 70 miles extending into southwestern New York State. The termius of this new line will be a short distance from picturesque Niagara Falls and Canadian border.

The overall cost of this vital extension of TGT's main line will amount to approximately $40,000,000, with the Portsmouth-Buffalo portion estimated at $30,000,000. Deadline for the completion of this project has been set for early fall. The A. O. Smith Company of Milwaukee is to supply the 26-in. pipe required for the job and Dunn Brothers of Dallas has been awarded the stringing contract.

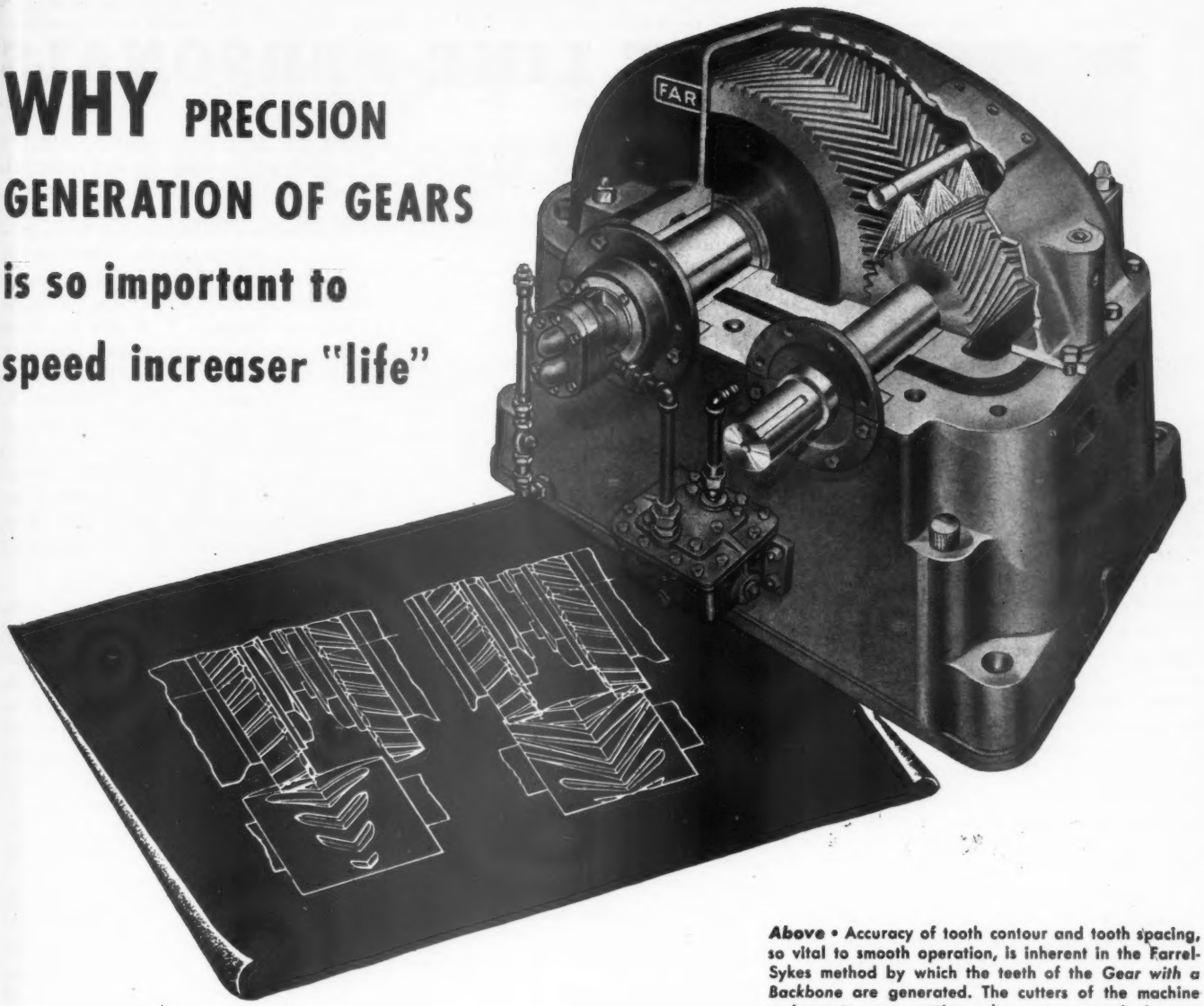
Construction work on the Portsmouth-Buffalo project will be under the direction of C. S. LeNoir, general superintendent of the HCPCO Pipe Line Division. Spread superintendents are C. R. Ice, G. A. Reutzel, R. K. Shivel, and W. B. Williams. At the peak of activities it is expected that more than 2000 men will be employed by the company on this new job.

Award Technology Fellowships

Sixteen young men were recently granted fellowships at the Institute of Gas Technology, effective next September. The recipients of these awards will study gas technology, and related subjects in business administration and pure and applied science. Each has shown scholastic ability as evidenced by superior grades.

The Institute of Gas Technology is the research and educational institution founded and supported by the American gas industry. Its educational program is designed to train men for positions of responsibility in the several phases of the manufactured and natural gas industries. The stipend currently amounts to $1250 annually in addition to tuition and remuneration from gas companies for summer work.

WHY PRECISION GENERATION OF GEARS is so important to speed increaser "life"



Above • Accuracy of tooth contour and tooth spacing, so vital to smooth operation, is inherent in the Farrel-Sykes method by which the teeth of the *Gear with a Backbone* are generated. The cutters of the machine reciprocate, one cutting when movement is in one direction and the other when the movement is reversed. Each ends its stroke at the center of the blank. As they cut, they twist to generate the helices and also slowly revolve in unison with the gear blank to generate the tooth contours precisely.

The problems involved in designing and producing gearing for high-speed units are quite different from those encountered in ordinary industrial transmissions. When pinions may operate at speeds as high as 9,000 RPM and pitch line velocities of gears may reach 10,000 FPM, even slight deviations from gear "perfection" result in excessive noise, vibration and premature wear.

The gears used in Farrel speed increasers are the continuous-tooth herringbone design—the famous *Gear with a Backbone*—precision generated by the Farrel-Sykes process. All gear generating equipment used in their production has been developed and manufactured by Farrel-Birmingham.

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PIPE LINE PERSONALS

H. G. Horstman

H. G. Horstman, for many years associated with the Public Service Company of Indiana, has been named director of sales and customer relations by Texas Gas Transmission Corporation, to succeed the late Everett P. Russell, and that **W. M. Elmer,** company treasurer, has been elected a vice president.

For the last five years Horstman has been personnel director of Public Service Company of Indiana. Previously, he served in that company's operations department as assistant to the vice president, and in the years between 1933 and 1944 he was gas and water distribution engineer.

Horstman is a graduate of Purdue University where he obtained a degree in chemical engineering. He has been connected with Northern Indiana Gas and Electric Company, the Peru Gas Company, and Utilities Service Company.

He is a past president and director of the Indiana Gas Association and has served as chairman of several American Gas Association committees.

Elmer has been with Texas Gas since June, 1947, when he was employed as comptroller of Memphis Natural Gas Company, a predecessor company. In April, 1948, after the merger of Memphis Natural and Kentucky Natural Gas Corporation with and into Texas Gas, he was elected comptroller of Texas Gas. Last May he was appointed treasurer of the company.

Previously, he was associated for nine years in the Chicago and St. Louis offices of Arthur Andersen and Company, public accountants and auditors, where he devoted a major portion of his time to natural gas and other utility accounting.

Donovan P. Dugan was elected vice president of the Tuscarora Oil Company, Ltd., at the recent annual meeting held at its offices in Harrisburg, Pennsylvania. Dugan is a native of Morgantown, West Virginia. He is a graduate of Morgantown High School and studied civil engineering at West Virginia University. For a time he worked with United States Engineers on lock and dam construction and later worked with the Arizona State Highway Department on highway and bridge construction.

He joined the Tuscarora Oil Company, Ltd., in 1931 on field work in the State of New Jersey, and was transferred in 1935 to the engineering department at Harrisburg. In August, 1944, he was appointed assistant superintendent and in August, 1947, was made superintendent and a manager. In addition to his position as vice president, he continues in his position of superintendent.

Cecil B. Porter, superintendent of Division D, has been promoted to pipe line superintendent by Tennessee Gas Transmission Company. Prior to joining Tennessee Gas, he was employed by the Empire Refining Company at Ponca City, Oklahoma, the Iowa Power and Light Company at Lincoln, Nebraska, and the Northern Natural Gas Company of Omaha. Porter joined the staff of TGT in December, 1943, as welding inspector on the construction of the original line. He was made district superintendent at Campbellsville, Kentucky, a year later. In April, 1945, he was promoted to assistant pipe line superintendent of the eastern division. When the company divided the system into four operating divisions in July, 1946, Porter was made head of Division D.

Bill Wilkins has been made chief of the transportation branch of the pipe line and production department of Gulf Oil Company. His headquarters are in Pittsburgh, Pennsylvania.

Delbert Jones, master mechanic of Gulf Refining Company, Tulsa Pipe Line Division, was discussion leader of the forum type meeting held by The Pipe Liners Club of Tulsa at its monthly meeting in May. He was assisted by a panel that included **Roy Ball, G. G. Billings, C. F. Gearhart,** and **E. M. Henderson.** The topics discussed were: (1) The place of research in the pipe line organization; (2) The determination of pipe size in suction lines; (3) Safe working pressures for pipe; (4) Estimation of operation and maintenance costs for pipe lines of various sizes; (5) Maintenance cost per horsepower-hour for diesel engines up to 400 rpm; (6) The location and repair of corrosive areas in pipe lines, and (7) Leak repairs—methods and materials used, costs encountered, and records.

Walter E. Baldwin has been promoted to assistant to the superintendent of communications and transport facilities by Shell Pipe Line Corporation, and **George T. Kelly** has been elevated to communications engineer. Both men are at the company's main office in Houston, Texas. **Byron E. Miller** has been made communications supervisor of the Texas-Gulf area, also having his headquarters at Houston. **Thomas W. Stanley** has joined the organization as wire chief, and **R. N. Randall** becomes assistant wire chief.

Thomas E. Bates, who has been connected with affiliated companies of Texas Gas Transmission Corporation, Owensboro, Kentucky, for more than 20 years, has been named supervisor of surveys for Division 111. He will be responsible for surveys, mapping, and other engineering functions. Prior to his transfer to the engineering department he performed the same general duties in the land and lease department.

William A. Koros has been employed as rate accountant. Since 1941 he has been a senior rate accountant on the rate staff of the Federal Power Commission. In his present post he will work with the engineering and accounting departments on all phases of present and future gas sales rates.

William N. Von Lehman has been made payroll accountant. He has been with the company since November, 1949, in the plant accounting department.

Ira P. Robinson, formerly with Interstate Natural Gas Company, Monroe, Lousiana, has been appointed superintendent of dispatching. With Interstate he had held the position of division chief and chief dispatcher since 1944.

Marvin C. Clayton has been made assistant to **Frank R. Baker,** supervisor, ad valorem taxes.

Ralph W. Thacker has been appointed supervisor of employe relations in the public and employe relations department.

G. E. Kendrick has been named assistant superintendent of the Jal, New Mexico, division of El Paso Natural Gas Company.

R. D. Butchofsky has been appointed field representative of the transportation department. He was previously a main line dispatcher.

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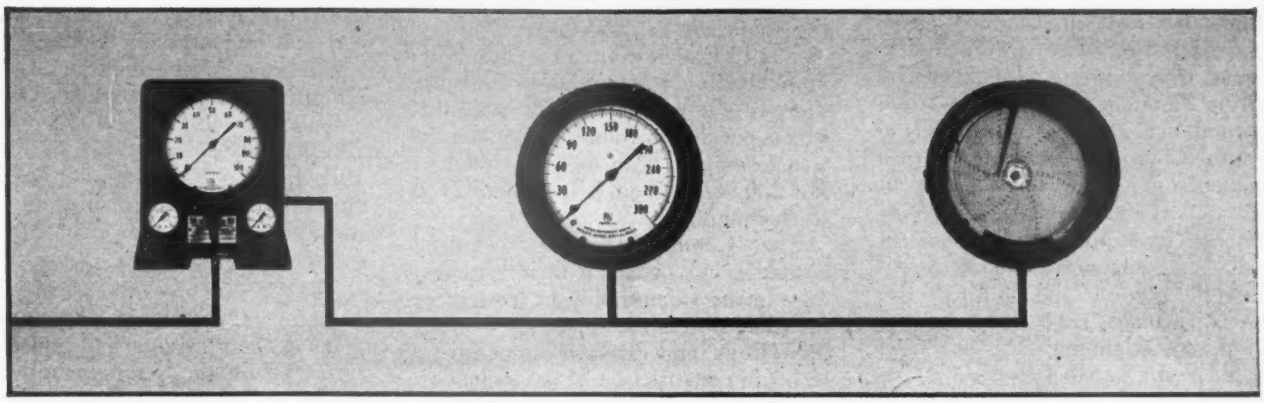

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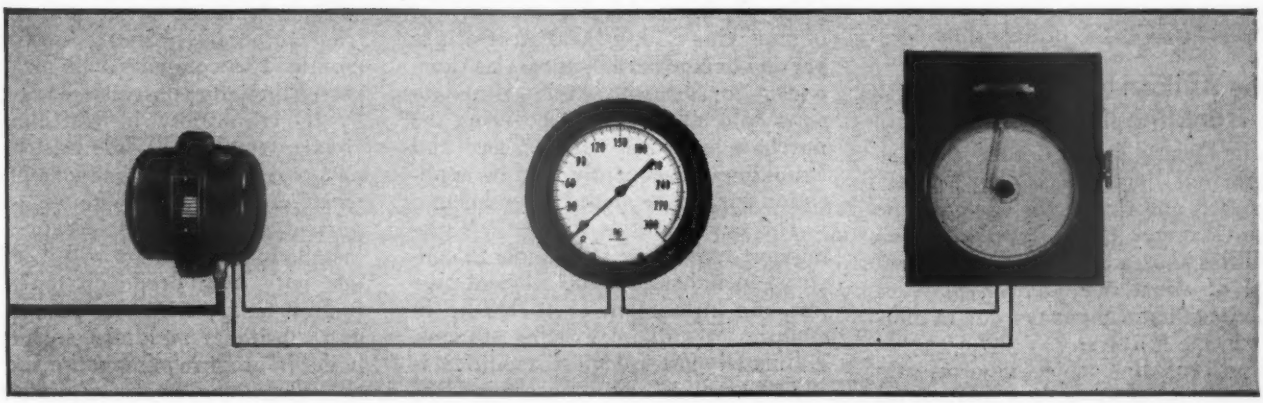

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PIPE LINE PROJECTS

Phillips to Construct 281-Mile Oil Line

Plans for a 10-in. crude oil pipe line from Borger, Texas, to Yale, Oklahoma, have been announced by Phillips Pipe Line Company, a wholly-owned subsidiary of Phillips Petroleum Company, according to a statement by K. S. Adams, president of the parent company.

The 281-mile pipe line will make it possible to transport West Texas and Panhandle crude to the Phillips refineries at Kansas City, Kansas, and Okmulgee, Oklahoma. The new line will fill in the gap between the existing 12-in. line from Odessa, Texas, to Borger, Texas, and the present 8-in. line from Yale to Kansas City. No contracts for the new line have been let and construction is not expected to start for several months.

The Texas production will supplement the refinery's crude supply, received chiefly from Oklahoma and Kansas fields at the present time.

New Authorization Made To Trunkline Gas Supply

The Federal Power Commission has authorized Trunkline Gas Supply Company and Panhandle Eastern Pipe Line Company to construct pipe line facilities that will carry a combined total of about 300,000,000 cu ft of additional natural gas per day to markets in the Midwest.

The Trunkline project involves construction of a 740-mile Louisiana-to-Illinois main transmission line, which will carry approximately 250,000,000 cu ft daily, largely for delivery to Panhandle. Panhandle was authorized to construct additional facilities on its system to enable it to transport the gas it will receive from Trunkline plus an additional 50,000,000 cu ft daily, which it will draw from the Panhandle and Hugoton gas fields.

The Commission ordered further hearing on the Panhandle application to commence June 12 in Washington, D. C., with respect to the distribution of the additional gas among Panhandle's present and prospective customers and the tariff and rate level applicable to gas deliverable.

Trunkline's construction program involves, in addition to the 740-mile main line, approximately 560 miles of laterals and 32,000 hp in main line compressor stations. Estimated cost of the project is $80,084,000.

The FPC conditioned the Trunkline authorization by requiring the company to allocate up to 1,500,000 cu ft of gas per day to Southeastern Illinois Gas Company, with the remainder of the 250,000,000 cu ft to be delivered to Panhandle.

The Commission also required Trunkline to submit a tariff satisfactory to the Commission at least three months prior to the commencement of operations, and directed the company to begin construction of its project on or before June 30, 1950, and to complete the job by October 26, 1951.

The Trunkline authorization was in the form of an amendment of the certificate previously granted to that company. The FPC on April 29, 1949, authorized Trunkline to build a 711-mile pipe line from Edge, Texas, to Palmyra, Nebraska, for the purpose of supplying 250,000,000 cu ft of gas per day to Northern Natural Gas Company. Northern, however, refused to enter into an agreement covering the purchase and sale of the gas and Trunkline subsequently filed its application for the proposed amendment.

The new facilities which the Commission authorized Panhandle to construct include about 160 miles of pipe line and installation of 16,000 hp in compressor units at existing stations. Estimated cost of these facilities is $15,944,500. In addition, certain facilities previously authorized by the Commission were approved for construction in conjunction with the new expansion program. These facilities include approximately 188 miles of line and additional compressor units at existing stations, to be built at an estimated cost of $14,221,000.

Although the Commission granted authorization for the previously authorized facilities, it said that the status of these outstanding authorizations should be an issue in the hearings scheduled to begin June 12.

Panhandle, which has its main office in Kansas City, Missouri, recently obtained a 60 per cent ownership of the outstanding common and preferred stock of Trunkline. Trunkline's address is Washington, D. C.

Overland Pipe Line for Grangemouth Refinery

Details relating to the laying of an oil pipe line crossing Scotland from Loch Long to the enlarged Grangemouth refinery of Scottish Oils, an associated company of the Anglo-Iranian Oil Company, are now available. For some time past it has been apparent that existing shipping facilities at Grangemouth docks are insufficient.

The plan involves the setting up of a major tanker depot and pumping plant at the receiving end and an adjustment at the Grangemouth end, where it had been expected that oil would be imported by tanker. The crude oil import installation is to be established at Finnart, Loch Long, one of the arms of the Firth of Clyde. This will enable Grangemouth docks to concentrate more on the handling of outward bound petroleum products.

From Finnart crude oil will be transported by pipe line to Grangemouth. The company will make full use of the jetty constructed at Finnart by the Admiralty in wartime, and voyage from the Middle East to Finnart as compared to Grangemouth will mean a saving of 24 hours, an important economic consideration. The installation at Finnart will consist of one jetty, four crude oil tanks, two fuel oil tanks, one main pump house and subsidiary buildings, including a boiler house, fire pumphouse and electric substations, as also administrative and welfare buildings.

The pipe line across Scotland will be in two sections. The first represents the existing Admiralty 12-in. line running almost to Balloch on the Loch Lomond side. The second will be a new 12-in. line tied to the Admiralty system near Balloch.

The Grangemouth town council has asked Scottish Oils to plan a different approach to the refinery on the ground that a given area of land will require to be "sterilized" on either side of the pipe line, since the present approach cuts through land intended for housing. The capacity of the pipe line will be 2,000,000 long tons a year, and the entire project will entail an outlay of close to £2,500,000.

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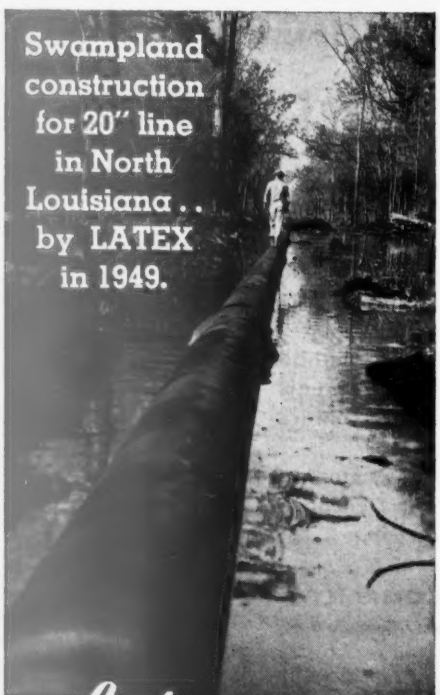

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PROJECTS

Texas Eastern Files An Amended Application

Texas Eastern Transmission Corporation, of Shreveport, Louisiana, has filed an amended application with the Federal Power Commission proposing to expand the daily sales capacity of its pipe line system by 476,000,000 cu ft to supply additional natural gas to its present customers and to provide Algonquin Gas Transmission Company with gas for resale in New England.

The project would make available to Algonquin 260,000,000 cu ft of gas per day, with substantially all the remaining quantities to be sold to present customers. Algonquin now has an application pending before the Commission for authorization to build a $33,217,090 natural gas pipe line system in the New England area.

Texas Eastern's amended application was filed as a substitute for an earlier application under which it proposed to construct its own pipe line system in New England, making available up to 200,000,000 cu ft of gas per day to that area. The new plan calls for deliveries to be made to Algonquin at a connection near Lambertville, New Jersey.

The new facilities, which would bring the total daily sales capacity of the Texas Eastern system up to 1,216,000,000 cu ft, include 791 miles of 30-in. pipe extending from a point near Kosciusko, Mississippi, to a connection with the company's existing system near Connellsville, Pennsylvania. Seven compressor stations with an aggregate installed horsepower of 46,400 would be built on the new line, with six additional stations with a total installed horsepower of 52,500 to be built on the existing system.

In addition, Texas Eastern plans to build 8.2 miles of 16-in., 2.2 miles of 12¾-in., and 3.3 miles of 10¾-in. pipe lines in the Metropolitan New York area to new points of deliveries to Public Service Electric and Gas Company of New Jersey.

Texas Eastern said that it plans in another application to ask FPC authorization to acquire and operate gas storage facilities near the Connellsville, Pennsylvania, connection. Total estimated cost of the proposed Texas Eastern construction program, including these storage facilities, is $117,806,400.

Texas Eastern said it has entered into an agreement with United Gas Pipe Line Company whereby that company will sell Texas Eastern 134,000,000,000 cu ft of gas per day.

Central Kentucky Natural Asks Expanded Capacity

Central Kentucky Natural Gas Company, of Charleston, West Virginia, has asked the Federal Power Commission to authorize the construction of pipe line and compressor facilities designed to carry natural gas to its wholesale customers in the Cincinnati, Ohio, market area.

The project would increase capacity of the company's system from 191,500,000 cu ft a day to an estimated 229,500,000 cu ft daily. The additional volumes of gas would be received from Tennessee Gas Transmission Company.

The proposed construction program includes approximately 32 miles of 20-in. loop pipe line extending from North Means, Kentucky, northwesterly to a point in Nicholas County, Kentucky. In addition, the company proposes to install one 880-hp gas engine driven compressor unit at its North Means compressor station. Estimated cost of the construction program is $2,195,000.

Pipe Line, Underground Gas Storage Proposed

The East Ohio Gas Company, of Cleveland, Ohio, has filed two applications with the Federal Power Commission proposing the construction of natural gas pipe line and underground storage facilities in northeastern Ohio.

In its first application East Ohio is seeking authorization to build about 24 miles of line extending from a point of connection near Petersburg, Ohio, with Tennessee Gas Transmission Company's Kentucky-to-Buffalo transmission line, now under construction, to East Ohio's Austintown station near Youngstown.

East Ohio's second application asks authorization for the construction and operation of gas storage inlet and outlet lines in Columbiana, Mahoning, and Portage counties, Ohio, a compressor station in Columbiana County, and the operation of an underground natural gas storage pool in Columbiana County.

The construction program would include two 8⅝ in. lines totaling 12.3 miles in length; a 940-hp compressor station, gas engines for which would be moved from East Ohio's Franklin station in Summit County; and an underground gas storage pool consisting of 13 wells. The underground pool would be used to store gas which East Ohio will purchase from Hope Natural Gas Company. The storage facilities are estimated to have an ultimate capacity of approximately 2,400,000,000 cu ft with a daily deliverability capacity of about 33,000,000 cu ft.

FPC Schedules Hearing On Algonquin Proposal

The Federal Power Commission has scheduled a hearing on Algonquin Gas Transmission Company's application to build a natural gas transmission system in New England to begin "as soon as practicable" following the hearings now being held in Boston on the competing application of Northeastern Gas Transmission Company, which also is seeking authorization to build a pipe line system in New England.

Algonquin had requested that matters relating to its market requirements be set for hearing in Boston on a date immediately following or in conjunction with the Northeastern hearing, which began May 8.

In its motion, Algonquin said that Northeastern's proposed facilities comprise a project that is in competition with and directly opposed to the Algonquin plan. The motion pointed out that certain gas distributing companies have signed gas contracts with Algonquin or Northeastern only, and a large number of distributing companies have signed letters of intent with both Algonquin and Northeastern to enter into contracts for the purchase of natural gas. Algonquin contended that a full and complete record of the New England area's natural gas requirements cannot be made without the participation and supporting evidence of the customers.

The Algonquin project, estimated to cost $33,217,090, would have an initial delivery capacity of about 260,000,000 cu ft a day. The proposed transmission system would include a main 254-mile line extending from a point of connection with Texas Eastern Transmission Corporation's facilities near Lambertville, New Jersey, to a point in the Boston area; approximately 364 miles of laterals, and a compressor station near Middletown, Connecticut.

Northeastern Gas Transmission Company's proposed New England project would include 545 miles of line and is estimated to cost $22,350,000. The Northeastern system would have an initial capacity of about 285,000,000 cu ft a day, which would be supplied by Tennessee Gas Transmission Company and Transcontinental Gas Pipe Line Corporation. Northeastern proposes to receive gas from Transcontinental at a connection on the New York-Connecticut State boundary near Greenwich, Connecticut, and from Tennessee at the New York-Massachusetts State boundary near Pittsfield, Massachusetts.

Both Northeastern and Algonquin have main offices in Boston.

Mississippi River Fuel Files Amended Application

Mississippi River Fuel Corporation, of St. Louis, Missouri, has filed a second amended application with the Federal Power Commission in connection with its plan to increase the daily sales capacity of its natural gas transmission system from about 266,000,000 to 375,000,000 cu ft.

Under plans set forth in the second amended application, the company would install compressor units totaling 28,380 hp in seven new stations, and additions totaling 4100 hp in two previously authorized stations. In addition, Mississippi River Fuel would build a 40-mile, 20-in. line from a point near Dubach, Louisiana, to its Perryville, Louisiana, compressor station, and 0.7 miles of 24-in. line and four 12-in. lines in a crossing of the Mississippi River in the metropolitan St. Louis area.

The seven new compressor stations are to be built by a third party at an estimated cost of $5,392,200 and leased to Mississippi. The compressor facilities to be added by Mississippi to its existing stations, the 40-mile line, and the river crossing have a total estimated cost of $3,947,696.

In its first amended application filed earlier this year, Mississippi planned to install 27,000 hp in the seven new stations and additions totaling 5000 hp at the the two previously authorized stations. Cost of the stations to be built by the third party was estimated at $5,400,000.

Arkansas Louisiana Gas Plans New Station

Arkansas Louisiana Gas Company, of Shreveport, Louisiana, has asked the Federal Power Commission to authorize the construction and operation of a compressor station, near Blanchard, Louisiana.

The company said the compressor station is part of an overall program begun with construction of facilities in Texas, Arkansas, and Louisiana as authorized by the Commission last September. That program included construction of a 72-mile line from the Waskom gas field in Texas to a point in Columbia County, Arkansas, and 90.8 miles of line from the Columbia County point to Perla, Arkansas. The new application says that the proposed Blanchard station will make additional gas supplies available to the Waskom-Columbia-Perla line.

The proposed station would have an ultimate installation of five units of 1400 hp each or a total of 7000 hp, and an initial installation of three units for a total of 4200 hp. Cost of the construction of the 7000 hp station is estimated at $1,170,000.

Proration Forces Changes In El Paso's Plans

The Federal Power Commission has authorized El Paso Natural Gas Company, of El Paso, Texas, to make changes in three previously authorized pipe line projects located in Texas, New Mexico, and Arizona.

The facilities as previously authorized are designed to deliver 405,000,000 cu ft of gas per day to Southern California Gas Company and Southern Counties Gas Company of California, and 250,000,000 cu ft daily to Pacific Gas and Electric Company.

Estimated cost of the additional facilities to be constructed is $12,952,069; however, the company will save an estimated $9,338,972 on previously authorized facilities that will not now be constructed, making a net additional expenditure of $3,613,097. El Paso said it has sold $12,000,000 in first mortgage bonds and $16,000,000 in sinking fund debentures.

Transcontinental Authorized To Expand Facilities

The Federal Power Commission has authorized Transcontinental Gas Pipe Line Corporation, of Houston, Texas, to expand the capacity of its Texas-to-New York City natural gas pipe line, now under construction, from the presently authorized 340,000,000 cu ft a day to a new total of 505,000,000 cu ft.

The new facilities will mean additional gas for Transcontinental's present and proposed market areas in New York, New Jersey, and Pennsylvania, and will provide natural gas service to municipalities in Virginia, North Carolina, Georgia, Alabama, and Louisiana.

The Commission in a concurrent order authorized South Jersey Gas Company, of Atlantic City, New Jersey, to build pipe line facilities in New Jersey to transport and sell natural gas received from Transcontinental.

The Transcontinental construction program authorized in the recent order includes the addition of nine compressor stations with a total compressor capacity of 134,560 hp.

Transcontinental's original application in the proceeding also proposed the substitution of different pipe sizes on certain sections of its Texas-New York City line. Upon motion of the company, this phase of the program was authorized by the FPC on March 1.

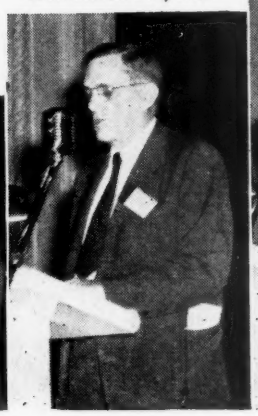
Overall capital cost of Transcontinental's modified and augmented pipe line system is estimated at approximately $240,000,000, as compared with an overall capital cost of approximately $191,000,000 as the project was authorized in 1948.

PICTORIAL

American Gas Association members at convention in Tulsa, Oklahoma.

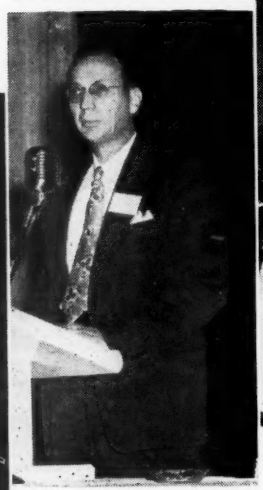
D. A. Hulcy
Lone Star Gas Company

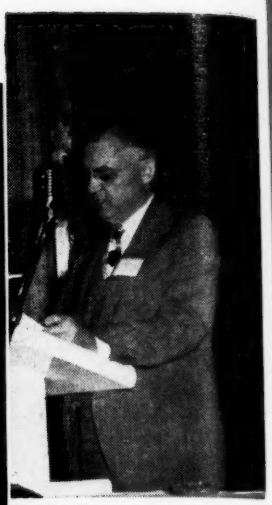
Harry Hancock
Gas Advisers, Inc.



Wesley E. Disney
Counsel, INGAA

Paul Mullins
U. S. Bureau of Mines



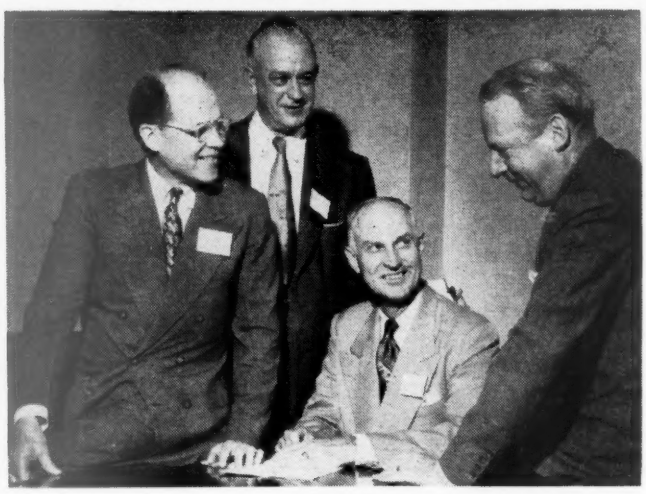


R. G. Strong, Natural Gas Pipeline Co. of America

Elmer F. Schmidt
Lone Star Gas

Lester Potter
Lone Star Gas Company

Below: H. N. Mallon, president, Dresser Industries; Hugh H. Cuthrell, president, AGA, and vice president, The Brooklyn Union Gas Company; A. H. Weyland, president, Arkansas Natural Gas Corporation; James F. Oates, Jr., chairman, Peoples Gas Light and Coke Company.



N. C. McGowen, chairman AGA Committee on Natural Gas Reserves, and president, United Gas Pipe Line Company.

AGA speakers: W. C. Mosteller, Southern Counties Gas Company; F. A. Hough, Southern Counties Gas Company; Paul Wilkinson, Magnolia Petroleum Company, and J. L. Oberseider, Southern California Gas Company.

At the National Association of Corrosion Engineers convention in St. Louis, Missouri, were: Earl Unruh, Sinclair Pipe Line, L. F. Scherer, The Texas Pipe Line Company, L. A. Baldwin, Johns Manville; H. S. Riddle, Columbia Gas System, and J. C. Stirling, Service Pipe Line Company.

Also attending NACE are: Below, Bob McCarthy, Hill, Hubbell and Company, and J. M. Pearson, Sun Oil Company; at right, W. H. Stewart, Sun Pipe Line Company, and Kirk Logan, Cast Iron Pipe Research Association.

For the second time in three years, Shell Pipe Line Corporation has won first place in the personal injury safety contest for oil and gas pipe line companies sponsored by the National Safety Council. W. I. Kent, past general chairman of Council, presents plaque to D. M. Farrell (second from right), head of the firm's safety and training program. T. E. Swigart (right), president of Shell, and H. H. Anderson (left), vice president and general manager, look on.

Hansford Z. Hight and Paul Marx, Dresser Manufacturing Division of Dresser Industries, Inc., have a chat at NACE meeting.

XUM

With the PIPE LINE CONTRACTORS

Associated Pipe Line Contractors, Inc., P. O. Box 2163, Houston, Texas, is double-jointing pipe at a rack in Timonium, Maryland, to lay for Transcontinental Gas Pipe Line Corporation. Right-of-way work began in May and the pipe gang will get started in June. The contractor is laying 75 miles of 31-in. pipe between Rockville, Maryland, and Conawingo, Pennsylvania. W. H. Flowers is in charge of the rack, and James Luther is managing the field office, which is at Towson, Maryland.

Progress is being made on the 111 miles of 22-in. crude oil line the company is constructing for Mid-Valley Pipeline Company between Mayersville and Holly Springs, Mississippi. J. A. Williamson is general superintendent, L. H. Gray spread foreman, Buck Fields assistant spread foreman, W. F. Van Cleave and Jack Bradley office men, and Keller Davis is in charge of the welders.

A river crossing is being installed at Beaumont, Texas, for Magnolia Petroleum Company, that will require the laying of 5 miles of pipe of various sizes. Cecil Rogers is spread foreman and Ralph Herwig is in charge of the office.

H. C. Price Company, P. O. Box 1111, Bartlesville, Oklahoma, has four spreads at work on a total of 220 miles of 26-in. for Tennessee Gas Transmission Company. Spread 1 began work May 1 under the superintendency of G. A. Reutzel and is laying 63 miles southwestward from the south bank of the Mahoning River, near Youngstown, Ohio. Headquarters are at Columbiana, Ohio. Spread 2 is laying 63 miles northeastward from the north bank of the Muskingum River. This spread began work April 17 and is in charge of R. K. Shivel. The field office is at Zanesville, Ohio. Spread 3 is working southwestward from the south bank of the Muskingum River 47 miles. Headquarters are at McConnelsville, Ohio, with W. B. Williams the superintendent. Work began April 17. Spread 4 also is laying 47 miles, extending northeastward from the north bank of the Ohio River. C. R. Ice is the superintendent and headquarters are at Sciotoville, Ohio. This spread also "kicked off" April 17. Beginning in August of this year the contractor will lay the balance of the project, consisting of 373 miles from the north bank of the Ohio River to a point near Buffalo, New York.

Britton Contracting Company, Inc., 93 South Main Street, Washington, Pennsylvania, is laying 40 miles of pipe varying in diameter from 8 to 20 in. for Central Hudson Gas and Electric Corporation between Port Jervis and Poughkeepsie, New York. "Curley" Hahn is superintendent and R. L. Carlton is managing the field office. Several jobs are being done for Tennessee Gas Transmission Company. Three river crossings are being installed in Pennsylvania: (1) Mahoning River, (2) French Creek, and (3) Beaver River. The field superintendent is Fred Peters and J. J. Truax is managing the office. Work is just beginning. Three river crossings are also being installed in Ohio: (1) Muskingum, (2) Ohio, and (3) Hocking. This work also is just beginning, with Hook Miller superintendent and Lorena McKenzie office manager. Between Beaver Falls and Pittsburgh 40 miles of 16-in. pipe is being laid with Fred McKenzie spread superintendent and J. J. Truax office manager. This job is just starting.

The job for Mid-Valley Pipeline Company, 111 miles of 22-in. between Russellville, Kentucky, and Louisville, is 20 per cent completed. The field office is at Leitchfield; Herb Britton is general superintendent, T. C. Pierce superintendent, and E. Howard Smith, Jr., office manager.

Bechtel-Price-Conyes, 220 Bush Street, San Francisco, California, is now working between Barstow and Mojave, California, on the Pacific Gas and Electric Company line, the 506-mile, 34-in. system being constructed between Topock, Arizona, and Milpitas, California. As a part of the work a double-ending plant is in operation at Barstow. R. L. Bowman is general superintendent, M. V. Scott, manager mainline office, Barstow, and Steve Valline, manager project office, San Francisco.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, is laying 202 miles of 30-in. for Transcontinental Gas Pipe Line Corporation, from Chatham, Virginia, to Spartanburg, South Carolina. Several jobs also are being done at the present time for Northern Natural Gas Company. Four loops totaling 222 miles are being laid from Borger, Texas, to the Nebraska line. Two river jobs, the Cimarron and Beaver, are being installed in Oklahoma and Kansas.

Latex Construction Company, 2707 Ferndale Place, Houston, Texas, announces the following construction work: For Mid-Valley Pipeline Company 41 miles of 20-in. crude oil line from Haynesville, Louisiana, to the Red River near Benton, Louisiana. H. L. Leake, superintendent; W. A. Briley, assistant superintendent; Sam B. Harrison, office manager; headquarters, Cotton Valley, Louisiana.

For Tennessee Gas Transmission Company, 123 miles of 30-in. gas line. Ninety miles of this work is from the vicinity of West Monroe, Louisiana, to a point near Many, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office; initial headquarters, Jonesboro, Louisiana. Right-of-way work began April 19, pipe laying late in May. The second section of this job is 33 miles from Jones, Louisiana, to the Mississippi River and is to be done later.

For Tennessee Gas Transmission Company, 54 miles of 16-in. and 12-in. gas line, from Kinder to Grand Chenier, Louisiana. F. A. Silar, superintendent; C. V. Oliver, office manager; headquarters, Kinder.

For Transcontinental Gas Pipe Line Corporation in South Louisiana, 85 miles of 4-in. to 14-in. gas gathering system. One spread started work April 20. J. B. Latham, superintendent; W. E. Bayles, office manager; headquarters, Vinton, Louisiana. A second spread is working from Abbeville, Lousiana, laying approximately 17 miles of 14-in. on this system. F. A. Silar, superintendent; C. V. Oliver, office manager.

For Tennessee Gas Transmission Company, 95 miles of 20-in. gas line, from Natchitoches to Kinder, Louisiana. F. A. Silar, superintendent; C. V. Oliver, office manager; headquarters to be Kinder, Louisiana. Preliminary began in May but pipe is not expected until about July 1.

For Tennessee Gas Transmission Company, 75 miles of 16-in. gas line, from Kinder, East to Bayou Sale.

J. L. Cox and Son, Raytown, Missouri, (stringing contractors,) has recently begun the stringing of 42 miles of 16-in. pipe between Wilmington, Illinois, and Dyer, Indiana, for The Texas - Empire Pipe Line Company. Between Kansas City and Omaha 43 miles of 12-in. for Great Lakes Pipe Line Company is just about completed.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors), are working on the following contracts:

H. C. Price Company (Tennessee Gas Transmission Company), 400 miles of 26-in. in Ohio, Pennsylvania, and New York, and 17 miles of 30-in. in Kentucky and Tennessee.

Eastern Construction Company (Mid-Valley Pipeline Company), 75 miles of 22-in.

Conyes Construction Company (Montana-Dakota Utilities Company), 340 miles of 12-in. in Wyoming and Montana.

El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Britton Construction Company (Tennessee Gas Transmission Company), 35 miles of 16-in. in Pennsylvania.

Texas - Southern Contracting Company, 804 Dan Waggoner Building, Fort Worth, Texas, has opened a field office and warehouse at Liberty, Texas, to lay 91.7 miles of 30-in. from a point near Deweyville, Texas, to Porters, Texas, for Transcontinental Gas Pipe Line Corporation. Merle Tatom is spread man and Lee Price is in charge of the office. Two river crossings will be installed as separate contracts, one of the Trinity near Liberty and the other of the Sabine near Deweyville.

The contractor also has moved in and begun work on 50 miles of 18 and 20-in. in the vicinity of Eunice, Louisiana, for Transcontinental. The office is at Crowley, Louisiana. Jimmy Reid is spread man and Pat Rogan has charge of the office.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, began laying early in May, 83 miles of 30-in. near Riverside, California, for Southern California Gas Company and Southern Counties Gas Company. The contract was taken as a joint venture with **Johnson Western Gunite Company** and the **L. E. Nixon Company,** Los Angeles.

Work was recently begun on 69 miles of 26-in. loop lines for Panhandle Eastern Pipe Line Company between Olpe and Hugoton, Kansas. The field office is at Ottawa. M. T. Wilhite is superintendent in charge and E. L. Rensch is office manager.

On the Great Lakes Pipe Line Company project, Section 23, 47 miles o 12-in. between Atchison, Kansas, and Falls City, Nebraska, is about 45 per cent completed. The field office is at Falls City. Section 24, 47 miles between Falls City and Nebraska, is approximately 55 per cent completed. The field office for this work is at Nebraska City. Section 25, 48 miles between Nebraska and Omaha, is about 45 per cent completed. The field headquarters are at Plattsmouth.

Scheduled to begin July 1 are 109.3 miles of 26-in. for Northern Natural Gas Company, extending from Palmyra, Nebraska, to Oakland, Iowa, and northeastward from the latter point a distance of 65.9 miles. This includes Sections 6, 7 of the project.

Lyle S. DeWitt is still stationed at Liberal, Kansas, as chief inspector on the Plains-Natural Gas Company gathering system. Midwestern did the engineering on projects B, C, and F, 120 miles of 4 and 24-in. near Hooker, Oklahoma.

Williams - Austin Company, Grant Building, Pittsburgh, Pennsylvania, completed on May 15, 10 miles of 20-in. for United Fuel Gas Company from Clendenin, West Virginia, to a storage field, and began work that date on 26.5 miles of 16-in. for New York State Natural Gas Company. The latter is from Charlevoi to Murraysville, Pennsylvania. Ralph Gaddy is superintendent. For Niagara-Mohawk Power Company, 32.5 miles of 10 and 14-in. is being laid from Therm City to Fulton, New York. The warehouse is at Phoenix, New York. Howard Bauer is superintendent. Planned for the future are 42.1 miles of 20-in., which will be laid for Central Kentucky Natural Gas Company from North Means compressor station to Foster, beginning July 15 with Ralph Gaddy the superintendent. For Acme Gas Company, 25 miles of 6, 8, and 10-in. pipe will be installed between Elwood and Butler, Pa.

Smith Contracting Corporation, 1410 Fort Worth National Bank Building, Fort Worth, Texas, is laying 196 miles of 30-in. pipe for Transcontinental Gas Pipe Line Corporation, from Chatham, Virginia, to the Potomac River. The field office for Section 10 is at Altavista. C. C. Craig is superintendent and Ben L. Mapes office manager. For Section 11 the field office is at Charlottesville, Virginia; H. J. McAdams, manager.

Pipe laying will not begin until sometime in July on the 108 miles of 16-in. between Baytown and Provident, Texas, for Texas Eastern Transmission Corporation, due to lack of pipe. Right-of-way work is being done, however, and road crossings bored.

Parkhill Truck Company, P. O. Box 1856, Tulsa, Oklahoma, (stringing contractor), is now working on contracts calling for the stringing of 1471 miles of pipe, as follows:

Lakehead Pipe Line Company (Anderson Brothers Construction Company, general contractor), 340 miles of 18-in. between Nechi, North Dakota, and Superior, Wisconsin.

Transcontinental Gas Pipe Line Corporation (Smith Contracting Corporation), 196 miles of 30-in. from the South Carolina border, to the Potomac River.

Mid-Valley Pipeline Company (Britton Construction Company), 108 miles of 22-in. between Russellville and Elizabethtown, Kentucky.

Mid-Valley Pipeline Company (Mahoney Contracting Company), 119 miles of 20-in., Hamilton to Lima, Ohio.

Salt Lake Pipe Line Company (Morrison-Knudsen Company, Macco Corporation, Bechtel Corporation), 120 miles of 8-in., Boise, Idaho, to Baker, Oregon.

Salt Lake Pipe Line Company (Pacific Pipeline and Engineers, Inc.), 120 miles of 6 and 8-in., Baker, Oregon, to Pasco, Washington.

Montana Power Company (Deaton and Sons, Inc.), 104 miles of 12-in., Bozeman to Butte, Montana.

Northern Natural Gas Company (Midwestern Constructors, Inc.), 109 miles of 26-in., Oakland to Holmes, Iowa.

Northern Natural Gas Company (R. B. Potashnick Company), 112 miles of 26-in., Holmes Iowa, to Farmington, Minnesota.

Panhandle Eastern Pipe Line Company (Anderson Brothers Construction Company), 75 miles of 26 and 30-in. loop lines between Houstonia, Missouri, and Edgerton, Ohio.

Panhandle Eastern Pipe Line Company (Midwestern Constructors, Inc.), 68 miles of 26-in. loop lines between Hugoton and Olpe, Kansas.

O. R. Burden Construction Corporation, 6702 East Twenty-first Street, Tulsa, Oklahoma, had completed 13 miles on May 17 of the 63 miles of 20-in. being laid for Mid-Valley Pipeline Company. The section is between Dixie, Louisiana, and Longview, Texas. Glen Lewis is superintendent and E. E. Haworth office manager. On the 42 miles of 16-in. between Wilmington, Illinois, and South Gary, Indiana, for The Texas-Empire Pipe Line Company, 6 miles had been completed. Pete Hiner is superintendent and Phil Whitaker office manager.

Canadian Bechtel, Ltd., and **Fred Mannix and Company,** Calgary, Alberta, Canada, are at work on the Interprovincial Pipe Line Company system. These two contractors are to lay 441 miles of 20-in. from Edmonton, Altamont, to Regina, Saskatchewan, Canada.

XUM

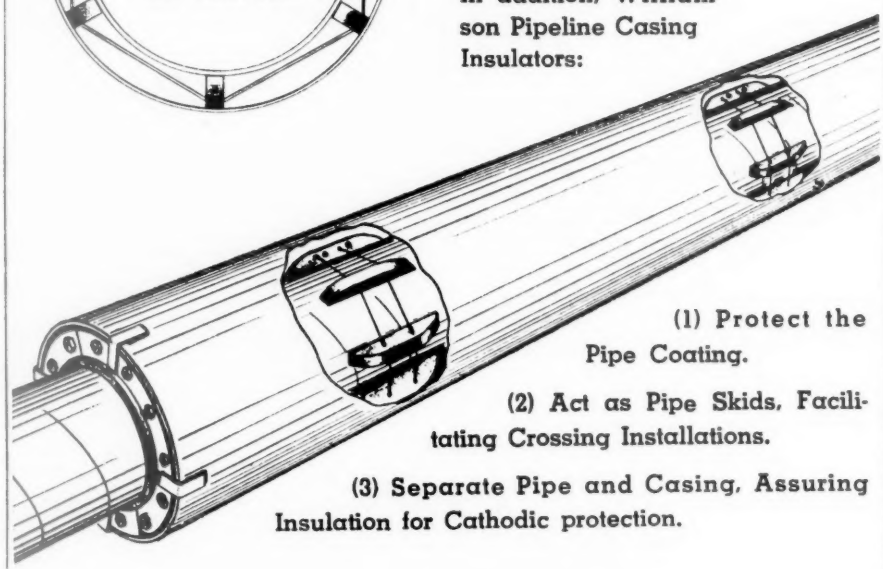
Mahoney Contracting Company, Hersee Building, Mt. Pleasant, Michigan, has completed 40 miles of the 120 miles of 20-in. pipe it is laying for Mid-Valley Pipeline Company from the Ohio River to Lima, Ohio. Just being completed for National Utilities Corporation are lateral lines from Grand Haven, Allegan, South Haven, Benton Harbor, and St. Joe, Michigan, to connect with the Michigan-Wisconsin Pipe Line Company system. This totals approximately 50 miles of 4-in. through 10-in. pipe.

Contracted with Panhandle Eastern Pipe Line Company is 50 miles of 26-in., which work will begin July 1. The line will extend from Waseon, Ohio, to Monroe, Michigan. Beginning about August 1, 50 miles of 22-in. will be laid for Michigan Gas Storage Company from St. Johns to Mt. Pleasant, Michigan.

Somerville Construction Company, Ada, Michigan, began work May 15 on 20 miles of 20-in. for Ohio Fuel Gas Company. The pipe is being laid between Mt. Gilead and Leesville, Ohio. Scheduled to start June 15 is 12 miles of 16-in. from Amherst to Berlinville, Ohio, for the same company.

WILLIAMSON "CONCENTRIC SUPPORT"
PIPE LINE CASING INSULATOR*

This improved Williamson Pipeline Casing Insulator approximately centers the line pipe in the casing. This removes support of pipe from "WmSEAL" Casing Bushings, and facilitates their installation. In addition, Williamson Pipeline Casing Insulators:



(1) Protect the Pipe Coating.

(2) Act as Pipe Skids, Facilitating Crossing Installations.

(3) Separate Pipe and Casing, Assuring Insulation for Cathodic protection.

FOR COMPLETE INFORMATION WRITE...

THE PIG WITH THE POKE CLEANS PIPE LINES

T. D. Williamson, Inc.
TULSA 9, OKLAHOMA

*Patent No. 2,097,398
Other Patents Pending

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, has moved its eastern office from Edgewater to Harrison, New Jersey, on the Transcontinental Gas Pipe Line Corporation job, which consists of 23 miles of 30-in. from Edgewater to Elizabeth. Louis Visentine is superintendent and Ernest F. Smith paymaster.

Construction began May 1 on 63 miles of 8-in. for Salt Lake Pipe Line Company form Mountain Home to Boise, Idaho. Office and warehouse are at Mountain Home. Aldress Kilgore is superintendent and R. F. Mueller paymaster.

Progress is being made on the 103 miles of 26 and 30-in. loops between Premont and El Campo, Texas, for Tennessee Gas Transmission Company. The field office is at Kingsville. M. E. Shiflett is superintendent and Joe Freeman paymaster.

Another job for Tennessee Gas Transmission Company is the laying of 91 miles of 30-in. from Holly Springs, Mississippi. Right-of-way is being made now but pipe work will not begin until the middle of June. Raymond Law is superintendent and Gene Gohring paymaster. The office and warehouse are at Holly Springs.

Construction will not begin on the Portland Pipe Line Company job until about June 15. The contractor will lay 85 miles of 18-in. from Portland, Maine, to Gorham, New Hampshire. The field office and warehouse are at Westbrook, Maine. H. A. Wylie will be in charge as superintendent with Lisle W. Chambers paymaster.

Eastern Construction Company, 1301 Mercantile Bank Building, Dallas, Texas, had laid 63.5 miles to May 18 of the Mid-Valley Pipeline Company job, which consists of 155 miles of 22-in. between Hornsby, Tennessee, and Russellville, Kentucky. Fred Byers is general superintendent. The main field office is at Waverly where J. W. Arthur is office manager. Two spread offices have been opened. At Clarksville, L. A. Stewart is spread foreman and J. D. Jones office manager. At Lexington, Cliff Simmons is spread foreman and Fred Harwell office manager.

Deaton and Sons, Inc., P. O. Box 2928, Odessa, Texas, is constructing 83 miles of 12-in. for Montana Power Company between Bozeman and Butte. W. F. Deaton is spread superintendent. H. H. Franklin office manager, and S. M. Scalf pipe foreman. When this job is completed 21 miles of 12-in. will be laid from Billings to the Wyoming border for the same company.

3 NEW LIGHTWEIGHT—

STRONGER Stainless STEEL

FIRE EXTINGUISHERS

Foam, Soda-Acid, Water Types

WITH NEW INDESTRUCTIBLE LABELS IN COLOR . . . AN INTEGRAL PART OF THE SHELL, UNREMOVABLE, MORE LEGIBLE, MORE EASILY CLEANED!

Approved by Underwriters' and Factory Mutuals Laboratories

Alfco engineers have utilized the strength, the lightness, the dependability, and the indestructibility of modern stainless steel to make this sparkling new series of 2½ Gallon Alfco Fire Extinguishers, the finest in their price class.

They are twice as strong as the old style fabricated copper units; about 50% lighter in weight without the charge; will retain their luster indefinitely; have new color label (patent pending) that is an integral part of shell, assuring lasting legibility of operation instructions.

All welded construction, elbow and collar silver brazed, no lead solder banks, no acid fluxes, corrosion resistant, both inside and out — a revolutionary improvement in fire extinguisher construction.

All 3 types are available: Firefoam 5F2, for Class A fires (Paper, Wood, Rubbish, etc.) and Class B fires (Flammable Liquids, Gasoline, Oil, Grease, Paint, etc.). Soda-Acid 5S2, for Class A fires, and Water Type 5H2, for Class A fires.

* Label Patent Pending

Tested to 500 Lbs.

ALFCO
TRADE MARK

AMERICAN-LA FRANCE-FOAMITE Corporation
ELMIRA · NEW YORK · U.S.A.

Now in our 2nd Century of LEADERSHIP *in* FIRE PROTECTION

XUM

E. R. Beauchamp, Jr.
Lane Wells

Gene Wedereit
Girdler-Tube Turns

Wm. H. Collins
Dravo

R. D. Mossman
Jones & Laughlin

Charles Down
General Electric

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Timken Roller Bearing

O. H. Barrett
Goodyear

T. S. Petersen
Standard of California

Francis F. Gregory
A. O. Smith Corp.

Wm. K. Beard, Jr.
Assoc. Bus. Publications

Lively Program Planned for NIAA Convention

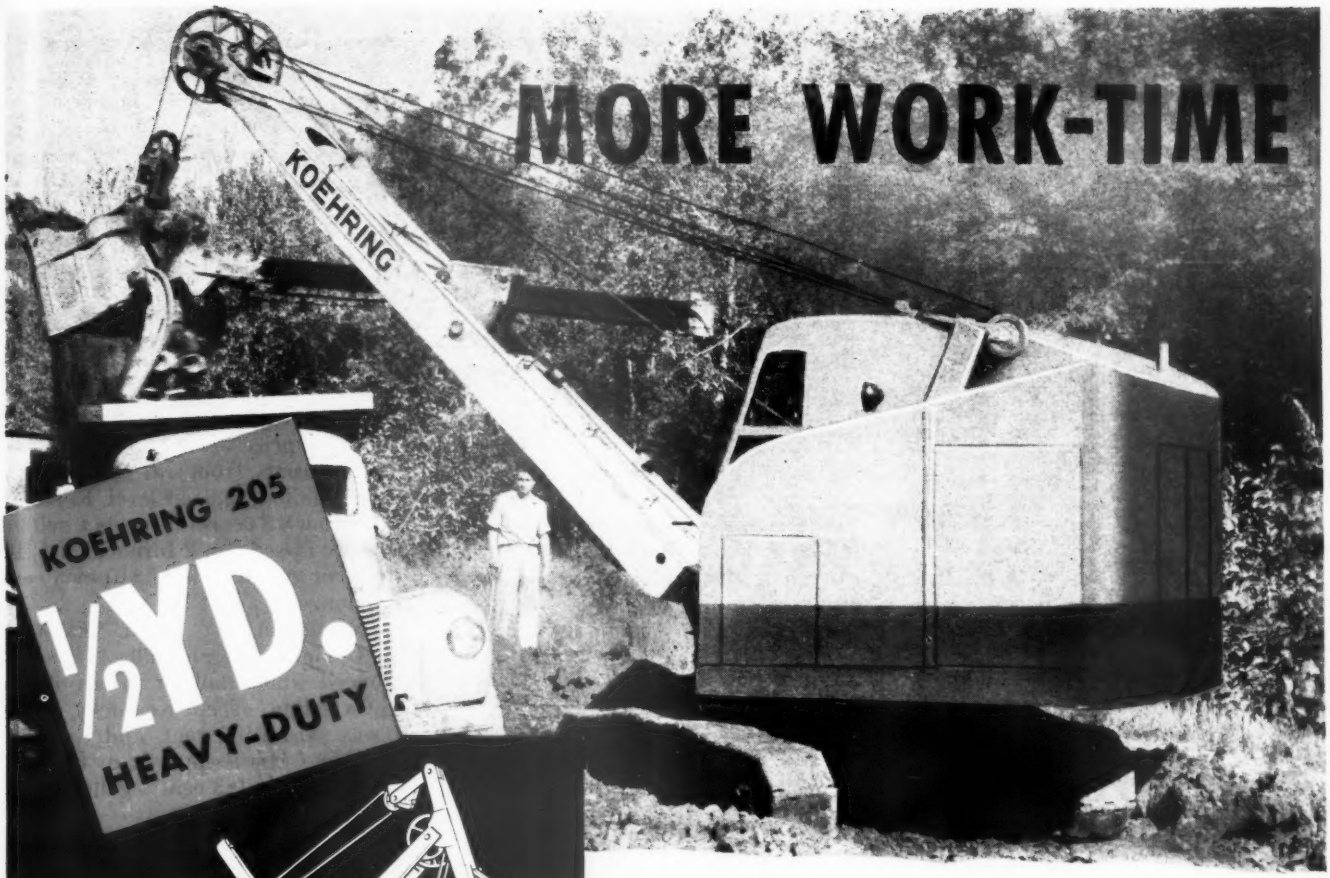
The National Industrial Advertisers Association will hold its 28th national conference in the Biltmore Hotel, Los Angeles, California on June 28, 29, 30, and July 1.

Registration for the conference will begin at 9 a.m. on June 28. At 10 that morning, the 1950 officers will hear the reports of progress covering the past year's work by chairmen of various committees, and plan future activities and policies. A summation of this work is reported to the membership. Cocktails will be served from 6 to 7 p.m., followed by a "Get-Acquainted" dinner.

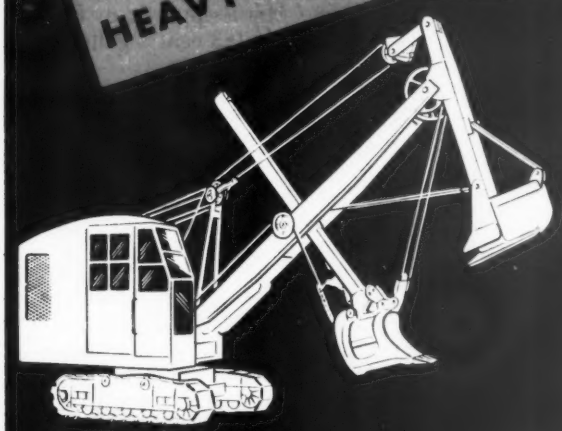
Bernard Dolan, president of NIAA and manager of sales and advertising, Peter A. Frasse and Company, Inc., New York City, will preside over the second day of the convention. He will make a report to the group, election of officers will be held, and reports from the various committees will be heard. In the afternoon, Edward Beauchamp, Jr., president of the Los Angeles chapter and advertising engineer, Lane Wells Company, will give the welcoming address, and the McGraw-Hill award will be presented. T. S. Petersen, Standard Oil Company of California, will be the keynote speaker. His address will be, "Management in the Middle." A forum on "The Business Outlook and Industrial Advertising" will be held later in the afternoon, with the panel being made up of various publishers and editors of trade publications. A publishers reception will be held at 5:30 p.m. at the Los Angeles Breakfast Club.

Friday morning will be devoted to the relationship between management and advertising. Schuyler Hopper, president, Schuyler Hopper Company, New York City, will be chairman of the discussion, and will review the aims and accomplishments of the committee on effectiveness of industrial advertising. Speakers are: Gene Wedereit, director of advertising, Girdler Corporation-Tube Turns, Inc., Louisville, Kentucky; Ray C. Helbig, advertising manager, Greenfield Tap and Die Corporation, Greenfield, Massachusetts; Francis F. Gregory, director of advertising, The A. O. Smith Corporation, Milwaukee, Wisconsin; Edward E. Beauchamp, Jr., advertising engineer, Lane Wells Company, Los Angeles; Robert D. Towne, vice president, W. L. Towne, New York City; R. D. Mossman, manager of advertising, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania; William H. Collins, director of advertising, Dravo Corporation, Pittsburgh, and J. F. Apsey, adverting manager, Black and Decker Company, Towson, Maryland.

In the afternoon individual and editorial awards will be presented by Col. Russell L. Putman, president, Putman Publishing Company, and Wm. A. Marsteller, vice president, Edward Valves, Inc., East Chicago, Indiana. Speaker will be O. H. Barrett, assistant to president, Goodyear Tire and Rubber Company of Canada, Toronto. Later in the afternoon a play, "Use of Consumer Technique in Industrial Advertising" will be given, with R. Calvert Haws, advertising manager, Western Precipitation Corporation, and



MORE WORK-TIME



DUAL PURPOSE BOOM SAVES UP TO 20% ON SHOVEL, PULL-SHOVEL COMBINATION . . . .

When you have pipeline foundation trenches or drainage ditches to dig, you can quickly convert this Koehring 205 from shovel to pull shovel. Both attachments use the same boom . . . conversion equipment costs 20% less than conventional units that require two separate booms. Quick convertibility to dragline, clamshell, lift crane or pile driver further increases its all-purpose efficiency.

INDEPENDENT TRACTION cuts non-productive time

Here's a heavy-duty excavator that gives you the fast-working speeds and mobility you need on oil field operation. You have 2-speed traction that is independent of all other operations . . . travels, swings, hoists, raises or lowers boom all at same time. Cuts non-productive time . . . steps up production on some work as much as 50%.

Chain drive gives fast operating speeds . . . crowds up to 84' per minute . . . retracts 143' per minute. Crowd and retract cable is self-contained in boom, stays intact when boom is removed . . . speeds conversion from shovel to other attachments . . . saves time lost in reeving.

Other Koehring 205 features that assure you more production at lower costs include: double-fulcrum clutch, to reduce manual operating effort . . . heavy-duty, accessible machinery, to minimize maintenance . . . choice of crawler mounting or pneumatic tires, to suit your exact operating conditions.

Get all the facts on this versatile Koehring heavy-duty Half-Yard *today*. Write for new 28-page catalog . . . or call your nearest Koehring distributor . . . located in all major oil field centers. Ask, too, about other Koehring sizes: ¾-yd. 304 . . . 1½-yd. 605 . . . and the big 2½-yd. 1005

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Sam Eastman, partner, Dozier Graham Eastman, Los Angeles, as producers.

The last day of the conference, Saturday, July 1, is designated "President's Day". Topics for discussion will include the manufacturers' catalogs, industry's evaluation of the trade show, what management expects from advertising, and selling free enterprise.

Attendance and NIAA publisher's sales presentation awards will be presented in the afternoon, with Paul G. Hoffman, administrator, Economic Cooperation Administration, Washington, D. C., as speaker. The rest of the afternoon will be devoted to television and what it means to the industrial advertiser today. The National Broadcasting Company will give a full-hour demonstration of a program as seen in the studio and also shown on a motion picture screen.

The 28th annual banquet Saturday evening will conclude the conference.

Refined Oil Demand Up

In the first 19 weeks of 1950, the demand for refined petroleum products averaged 7 per cent higher than the corresponding period in 1949, according to calculations made by the *Chicago Journal of Commerce*.

Demand averaged 5,476,000 bbl daily, an increase of 361,000 daily from the same period in 1949. Light fuel oil demand showed the largest volume gain. The demand for distillate fuel oil averaged an 11.8 per cent increase, and the gasoline demand increased 3.8 per cent from the year earlier period.

Kerosine was up 45,000 bbl daily, a 12.7 per cent increase, and the demand for heavy fuel oil averaged 1,330,000 bbl daily, a 7.1 per cent increase over the same period last year, the *Chicago Journal of Commerce* stated.

Retirement Plan Set Up

Continental Oil Company has liberalized its employee benefit plans to include a minimum retirement payment of $125 a month. Employees retiring at age 65 for men and 60 for women, and who have at least 20 years of service, will receive a minimum payment that, together with revised federal old age benefits, will total at least $125 a month.

Ohio Oil Awarded

The Ohio Oil Company has been awarded two first places, a second place, and a certificate of achievement in the National Safety Council's Safety Contest for 1949. The petroleum section of the National Safety Council contest includes entrants from the United States, Canada, Mexico, and Venezuela.

Boost Gasoline Prices

The general trend has been toward higher prices on petroleum products throughout the country. In Ponca City, Oklahoma, Continental Oil Company has announced an advance of ½-cent in the tankwagon price of all grades of gasoline to retail dealers and commercial consumers in Oklahoma, New Mexico, Colorado, and a few points in southeastern Wyoming.

Socony-Vacuum Oil Company, Inc. and Atlantic Refining have announced increases on their No. 2 home heating oil and kerosine in the East. Socony raised the price of No. 2 oil at Boston, Massachusetts from 7.6 cents to 7.8 cents a gallon, tankcar level. Kerosine went from 8.8 cents to 9 cents a gallon. Atlantic raised No. 2 furnace oil 4/10 of a cent and kerosine 3/10 of a cent a gallon.

Throughout the South, Standard Oil Company (Kentucky) has announced whole tankcar prices of 0.5 cent a gallon, except Kentucky where it was raised 0.2 cent, and Georgia, Alabama, Mississippi, and Florida, which will pay 0.3 cent a gallon more for gasoline.

South Penn Oil Company has increased the market price of various grades of Pennsylvania crude oil 11 cents a barrel.

In most of Texas, gasoline prices have been advanced to ¼ cent a gallon tankcar prices and ½ cent a gallon on tank wagon prices. Atlantic Refining Company posted an increase of 15 cents a barrel for oil purchased in five Louisiana and Texas coastal fields.

Equipment Men To Meet

The annual membership meeting of the Petroleum Equipment Suppliers' Association will be held June 25, 26, and 27, according to Guy A. Thompson, president. It will be held at the Greenbrier Hotel, White Sulphur Springs, West Virginia.

Set Canadian Field Limit

According to the estimates made by E. D. Wilson, division petroleum engineer for Imperial Oil Ltd., each 40 acres of land at Golden Spike oil field in Alberta, Canada has a crude oil reserve of about 3,240,000 bbl. Wilson made the estimate at a hearing of the Alberta Petroleum and Natural Gas Conservation Board.

The board is considering the most likely rate of production in the various oil fields of Alberta. Wilson recommended the board's daily allowable per well be set at 890 bbl. Imperial, which has three wells—each on a 40-acre tract in the Golden Spike field—has a self-imposed 160-bbl-a-day figure.

Texas Railroad Commission Sets Higher Quota

Top officials of the nation's oil industry met with the Texas Railroad Commission recently to discuss future crude oil production demands for 1950. Optimism ran high among oil men, who predicted that domestic demand for petroleum by the end of this year would reach a new record.

As a result of this over-whelming optimism, the Texas Railroad Commission raised Texas' June allowable 140,500 bbl per day.

In the following table, estimated total imports by leading companies are shown:

	Last half 1950 B/D	First half 1950 B/D	Last half 1949 B/D
Jersey Standard	226,500	246,819	201,606
Gulf Oil	105,000	105,000	117,000
Socony-Vacuum	69,000	69,000	64,500
Asiatic (Royal Dutch)	90,000	94,000	45,400
Atlantic Refining	62,500	50,000	37,300
Indiana Stand. (Affiliates)	45,200	35,600	36,900
California Standard	33,000	29,700	20,400
Sinclair	48,500	34,000	27,600
Shell Oil	14,006	17,400	21,300
Cities Service	8,000	10,700	9,800

* Based on figures supplied by House Small Business committee compiled from data of the Commerce Department.

H. S. M. Burns, president of Shell Oil Company, was most optimistic about rising demands. He expressed the belief that the U. S. will need at least 300,000 bbl daily more of crude petroleum, and "possibly by the end of the year, output may have to be increased by 500,000 bbl a day."

East of the Rockies, Eugene Holman, president of Standard Oil (New Jersey), estimated 400,000 bbl per day increase will be required. Robert C. Dunlop, president of Sun Oil stated that a slightly higher rate of production is required next month and posfurther increases later in the year.

The one pessimistic note was sounded by Hines H. Baker, president of Humble Oil and Refining Company, who was of the opinion that increased output should wait until increased demand is a reality.

Dr. Robert E. Wilson, chairman of Standard Oil (Indiana), ventured a prediction of a 19 per cent increase in demand for some heating oil next winter, and voiced the belief that kerosine consumption would increase 15 per cent next winter over last.

S. A. Swensrud, president of Gulf Oil Corporation, said, "Omitting any consideration of national defense, domestic oil requirements will continue to grow." And, "by another 10 years, we will be using 8,500,000 to 9,000,000 bbl daily of petroleum products," he predicted.

Oil Companies Resist Anti-Trust Charges

Oil companies are preparing to resist resolutely the Department of Justice's charge against them with conspiracy to "monopolize" the oil industry in the Pacific Coast area.

Named in the suit are California Standard, Shell, Texas, General Petroleum, Richfield, Tide Water Associated, Union Oil of California, and the Conservation Committee of California Oil Producers, which has been charged with running a "private proration" program to control production of crude oil.

The government's complaint charged that the companies had used "a private proration system" for their own advantage, discriminating in favor of wells owned by the defendants in applying production quotas and fixing quotas for wells of independent refiners at levels so low as to deprive them of a sufficient supply of crude and then refusing to sell crude to these independents.

E. N. Redden

W. D. Thorn

Frank J. Gardner

Name Committee To Study Texas Petroleum Industry

A 16-member petroleum industry committee has been appointed by Governor Allan Shivers of Texas to assist the state legislative council with a proposed study of the oil industry.

D. W. Hovey, president of Danaho Refining Company, Houston, is chairman of the committee, which will help the legislature study the importance of the oil industry to state government.

Committee members are: E. O. Bennett, R. J. Gonzales, Harry Leyendecker, Glenn McCarthy, and Pat R. Rutherford of Houston; Ray Hubbard, Sidney Latham, and Raymond M. Myers, of Dallas; H. E. Childs, Midland; Harold Dunn, Amarillo; John Lynch, Corpus Christi; Sid W. Richardson, Fort Worth; Fred Shield, San Antonio; Clay Underwood, Wichita Falls; John Wrather, Longview.

Sinclair Buys Assets

Sinclair Oil and Gas Company announces the purchase of a one-half interest in the physical assets of the former Lisbon Gasoline Company, Inc. These assets consist of two natural gasoline extraction plants, with field gathering and residue systems, located in the south end of the East Texas field. More than 1400 wells with a production of approximately 10,000,000 cu ft of casing head gas supply these plants, which have a productive capacity of about 60,000 gal of natural gasoline and butane, and 40,000 gal of propane daily. Sinclair will operate the plants through its Tulsa office.

Oil Reporting Service Established In Dallas

Establishment of a new oil publishing firm, to be known as Petroleum News Corporation, was announced in Dallas, Texas recently. Officers and directors are: E. N. Redden, president, Houston; W. D. Thorn, vice president, Dallas; Frank J. Gardner, secretary-treasurer, Dallas and Houston; L. R. Graham, West Texas manager, Midland, and T. D. Burnette, sales manager, Dallas.

The new corporation began operation in mid-May, publishing the *Five Star Oil Reports*. Coverage will include the states of Texas, New Mexico, and Louisiana. Publishing offices are in Midland, Dallas, and Houston.

The series of oil reference books authorized and edited by Gardner will continue under the sponsorship of the new firm. He is the writer of three recent books: *South Texas Oil*, *Texas Gulf Coast Oil*, and *West Texas Oil*. Next in the series is to be entitled *Oil, The Land, and You*, written for the land owner and lessor.

XUM

PERSONALS

John E. Allen, formerly assistant treasurer of the Gulf Oil Corporation, has been appointed to the newly created position of co-ordinator of foreign exchange.

In his new position Allen will co-ordinate and correlate all matters relating to foreign exchange for the company and its foreign subsidiaries. He joined the Gulf organization in 1930 and was appointed assistant treasurer the following year. He will continue to be stationed in the company's general offices at Pittsburgh.

C. A. P. Southwell, managing director, Kuwait Oil Company, Ltd., has been elected president of the Institute of Petroleum. Vice presidents are: **M. A. L. Banks,** manager of operating branch, refining division, Anglo-Iranian Oil Company, Ltd.; **E. J. Dunstan,** director, Manchester Oil Refinery, Ltd.; **F. Morton,** professor of chemical engineering, University of Birmingham; J. S. Parker, refinery manager, Lobitos Oilfields, Ltd., and **H. G. Tett,** general sales manager, Anglo-American Oil Company.

Members of the Council are: **W. S. Ault,** chief chemist, **F. L. Garton,** in charge (acting) of sales technical advisory department, **H. Hyams,** section head, technical division, **D. L. Samuel,** technical adviser on lubricants, sales technical advisory department, **E. J. Sturgess,** chief engineer, and **H. De Wilde,** advisory engineer, all of Shell Petroleum Company, and

C. D. Brewer, engineer-in-charge, research engine services section, Thornton research center, J. G. Hancock, technical assistant to general manager, Stanlow refinery, **E. Le Q. Herbert,** assistant general manager, of Shell Refining and Marketing Company, Ltd., and

E. B. Evans, research co-ordinator, **C. S. Windebank,** managing director, Esso Development Company, Ltd., and **V. Biske,** research chemist, Lobitos Oilfields, Ltd.; **H. S. Gibson,** managing director, Iraq Petroleum; **H. E. F. Pracy,** general manager, Trimpell Ltd.; **G. H. Smith,** chief chemist, Scottish Oils Ltd.; **R. B. Southall,** general manager, National Oil Refineries, Ltd.; **G. H. Thornley,** manager of the department for technical information, Messers. C. C. Wakefield and Company, Ltd.; **E. Thornton,** technical advisory staff, Anglo-Iranian Oil Company, Ltd., attached to National Oil Refineries, Ltd.; A. T. Wilford, superintendent of laboratories, London Transport executive.

Honorary secretary is **C. Chilvers,** manager, costs and operations department, Anglo-American Oil Company, Ltd., and **G. H. Coxon,** Anglo-Iranian Oil Company is honorary treasurer.

Ex-officio members of the Council are: **E. J. Horley,** South Wales branch, technical assistant, National Oil Refineries, Ltd.; **N. E. F. Hitchcock,** London branch, development chemist, Messrs. C. C. Wakefield Company; **I. McCallum,** Fawley branch, manager, technical service department, Esso Fawley refinery; **T. W. Ranson,** Northern branch, managing director, Ranson Grease Company, Ltd.; **A. G. V. Berry,** Stanlow branch, superintendent of research and development, Lobitos Oilfields, Ltd.; **W. M. Stirling,** Scottish branch, assistant chief electrical engineer, Scottish Oilfields Ltd.

Norman R. McKee, vice president of Southern Counties Gas Company of California, retired recently, after more than 35 years' service with the

NORMAN R. McKEE

company, and around 47 years in the gas and oil business in Los Angeles.

Born in Toronto, Canada, McKee came to California in 1903. He found employment first with the old Los Angeles Gas and Electric Corporation, remaining with that firm for four years. From 1907 to 1915 he was with the Associated Oil Company, and Standard Oil successively, joining Southern Counties Gas in 1915. He was elected vice president in charge of sales, purchasing, and public relations functions in 1934.

He is being succeeded as vice president in charge of sales and public relations by **Frank Wright,** former manager of the company's Ventura division.

R. C. Alden, chairman, **T. B. Hudson, W. A. Schulze,** and **K. H. Hachmuth** were appointed to a planning board set up by Phillips Petroleum Company. The board will be a part of the research and development department to facilitate long-term planning of the company's research and development program. The board will report to **G. G. Oberfell,** vice president of the department, through **R. W. Thomas,** manager.

P. M. Arnold will become the new assistant to the manager of the research and development department, and **R. L. Doan** will replace Alden as director, with **T. W. Legatski,** and **J. A. Reid** as assistant directors.

W. B. Reynolds has been named assistant director in charge of the chemicals and rubber branch of the research division. **F. W. Crawford** was appointed assistant director in charge of production and physics, and **D. E. Carr** was named assistant director in charge of combustion and lubrications. **F. E. Frey** has been put in charge of hydrocarbon conversion branch, and **R. W. Blue** transferred from production and physics branch to hydrocarbon conversion.

In the patent division **J. A. Young** replaces Hudson as manager, with **J. P. Jones** as assistant manager, and **D. J. Quigg** named one of the four legal branch section chiefs. **George Benz** remains as manager of the chemical engineering division with **C. K. Buell** as assistant manager.

An administration and personnel branch has been established in the research and development department to serve the four departmental divisions. **L. C. Morris** has been appointed office manager in charge of the new branch, with **R. R. Couch** as assistant office manager.

Howard Ellsworth Cole, former vice president and a director of the Standard Oil Company of New York who retired in 1930, died recently.

Cole became associated with Standard Oil Company of Cleveland, Ohio, becoming assistant to the vice president and then general manager of Waters-Pierce Oil Company, Mexico. He returned to this country in 1907, and was made general manager of Japan and Korea. He was made a director of Standard Oil of New York, in 1914, becoming a vice president in 1924.

Erasmo T. Guerrero has been awarded the Magnolia Petroleum Company Fellowship of $2000 for a 10-month period starting September, 1950, for work toward a doctorate degree in Petroleum Engineering at A. and M. College of Texas. He received his Bachelor of Science degrees in petroleum engineering and mechanical engineering in June last year, and in August, 1950 he will receive a Master of Science degree in petroleum engineering.

▸ **Wm. H. Merritt** of Chicago, Illinois, vice president of Cities Service Oil Company (Delaware) and manager of its marketing division, has retired from active service.

Merritt's retirement comes after 48 years with Cities Service, 14 of which were spent in developing the company's marketing and sales organization. His early experience with Cities Service was in the utility field, switching over to the refining and marketing phases of the oil industry in 1919. He served the company at Bartlesville, St. Paul, and Tulsa, Oklahoma, and Chicago. He was elected vice president and director of Cities Service and Cities Service Oil Co., Ltd., in 1936.

E. L. Stauffacher of Chicago, Merritt's assistant, will assume Merritt's responsibilities.

▸ **William A. Mussen,** responsible for various phases of radio-proximity fuze development and instrumentation in the U. S. Naval Ordnance Laboratory, has been appointed supervisor of the electronics laboratory at Southwest Research Institute in San Antonio, Texas.

A graduate of Washington and Lee University, Mussen, who came directly from the White Oak, Maryland, Naval laboratory to San Antonio, considers his special fields as oscillography, high frequency techniques, automatic control, etc.

▸ **J. Skliros** has been given the Insignia of Commander of the Legion of Honour, by the French Ambassador in London, in recognition of his services as managing director of the Iraq Petroleum Company, an office from which he retired December 31, 1949.

Skliros, accompanied by Mrs. Skliros, was guest of honour at a luncheon given in Paris recently by the Compagnie Francaise des Pétroles to celebrate his promotion in the French National Order, to which he was admitted in 1935. The luncheon was presided over by E. F. H. Mercier, former president of Compagnie Francaise des Pétroles, supported by V. de Metz, president; R. Cayrol, vice president; R. Perrin, vice president; M. Mercier, secretary, and A. de Grouchy, London representative, and their wives. Other guests from London were H. H. Wheatley and G. W. Dunkley, who were associated with Skliros for many years in the management of the Iraq Petroleum Company, and Mesdames Wheatley and Dunkley.

▸ **Dr. Charles Newton Kimball,** has been elected president of the Midwest Research Institute, Kansas City, Missouri. **George E. Ziegler** is director of research.

▸ **Norman H. Ricker** of The Carter Oil Company research laboratory, Tulsa, spoke May 26 at the Houston, Texas, regional meeting of the Society of Exploration Geophysicists on "The Primary Seismic Disturbance in Shale."

Ricker, a senior research physicist at Carter, is known for his invention of the paper cone loudspeaker which, with improvements, is used in present day radios. He has been with Carter for the last 12 years. Previously he worked for the Humble Oil and Refining Company and did private consultation work at Houston.

After receiving his doctorate in physics at Rice Institute in 1920, Ricker was engaged in telephone research until 1923. He is a member of The American Mathematical Society, the American Physical Society, Seismological Society of America, and the Society of Exploration Geophysicists.

▸ **P. C. Spencer,** president of Sinclair Oil Corporation and **Henry L. O'Brien,** first vice president of Cities Service Company have been elected to the board of directors of Richfield Oil Corporation. They succeed the late **Frederick H. Bartlett,** Chicago, Illinois, and **William T. Dinkins,** Los Angeles, California.

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▸ **C. R. Patterson** and **Ulice Callis,** Shell Oil Company, received the Joseph A. Holmes safety award from the Bureau of Mines in recognition of individual deeds of heroism in saving the lives of fellow workers in 1949. Callis entered a tin processing corporation smelter building that was filled with hydrochloric acid gas fumes and carried a fellow workman to safety. Patterson, although severely burned about the head and face in a flash explosion during drilling operations, managed to close a valve at the drilling head, thus averting further explosions and saving the lives of other workmen.

▸ **E. O. Mattocks,** technical representative of Phillips Petroleum Company, Bartlesville, Oklahoma, has joined the American Petroleum Institute as staff engineer in the newly-created department of technical services.

Authorized by the executive committee of the board of directors early this year, the department of technical services will be headed by **David Stroop,** executive assistant to the president.

The new department will operate in four fields. It will provide program and coordination services, which will correlate non-divisional and inter-divisional activities; engineering and research services, which will handle the Institute's fundamental research program and its affiliations with technical associations; accident and fire prevention services, and agricultural services. Mattocks is a graduate of Cornell University, and had been affiliated with Phillips Petroleum from 1937 until he resigned to join the API staff.

▸ **Grayson L. Kirk,** provost of Columbia University, has been named to the board of directors of the Socony-Vacuum Oil Company, Inc. He will be the first board member from outside the company in the history of Socony-Vacuum. The other ten members of the board are full time employees.

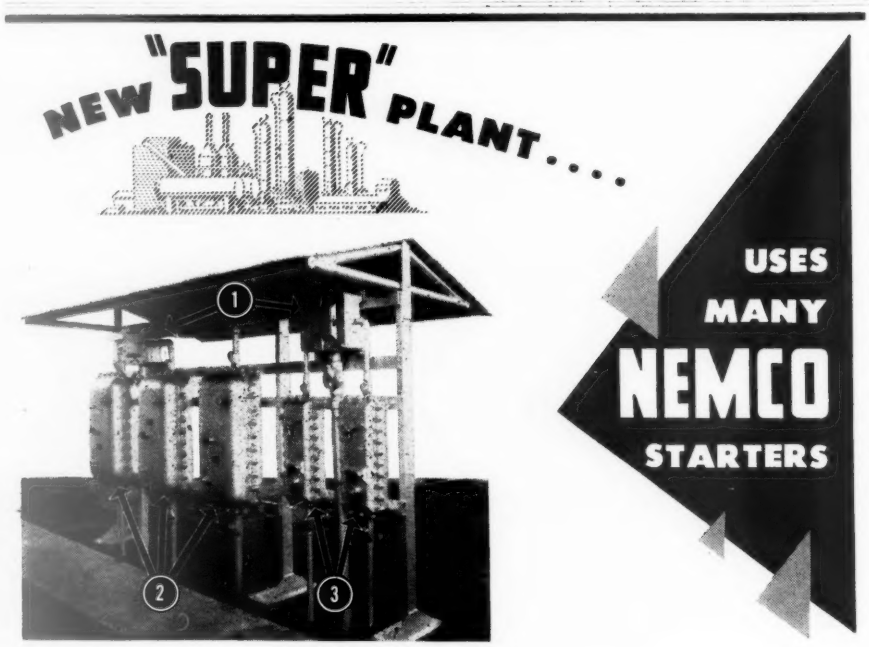
Kirk recently was named a vice president of Columbia and will assume that office on July 1 as principal assistant to Dwight D. Eisenhower, president. He has been a member of the Columbia faculty of political science since 1940 and holds the rank of professor of international relations.

A graduate of Miami University, Ohio, Kirk received his MA from Clark University in 1925, and his Ph.D. from the University of Wisconsin in 1930.

▸ **Maurice R. Schmidt** has been appointed by the Economic Cooperation Administration as petroleum consultant to its special representative in Europe, **Ambassador W. Averill Harriman.** Former manager of the Whiting, Indiana refinery of Standard Oil Company (Indiana), he succeeds **George Walden** who recently retired.

▸ **Don B. Camblin** has been promoted from administrative assistant to assistant manager of Continental Oil Company's industrial relations department. He will be succeeded by **Max E. Stansbury,** attorney in the Los Angeles offices. Camblin, an employee of Continental for nearly 25 years, was promoted to administrative assistant in the industrial relations department a year ago. He was graduated from high school in Tulsa and attended St. Joseph's College, Muskogee, Oklahoma. He joined Continental as a clerk in the purchasing department in 1926, becoming assistant director of service divisions in June, 1948.

Stansbury is a graduate of Oklahoma A&M College and received his law degree from the University of Oklahoma. He joined Continental as a clerk in the land department in 1936, and entered the army in 1942. He rejoined the company in 1947 as an attorney at Los Angeles.



1. "NEMCO" Explosion-Proof Junction Boxes with Low Voltage Bus. Write for Bulletin 481.
2. "NEMCO" Explosion-Proof Two-Speed Combination Motor Starters. Write for Bulletin 423.
3. "NEMCO" Explosion-Proof Single-Speed Combination Motor Starters. Write for Bulletin 420.

"NEMCO" Explosion-Proof Two-Speed and Single-Speed Combination Motor Starters are much in evidence throughout the area occupied by the new-type natural gasoline plant which has recently been installed in Garvin County, Oklahoma.

Described as a "super" plant because it actually represents the combined operations of *three* natural gas processing units located at Antioch, Lindsay and Maysville, Oklahoma, this plant is handling a conservation job of enormous scope.

The above field photo shows but one of many groups of "NEMCO" Explosion-Proof products, including starters, air circuit breakers and junction boxes, which were furnished for this project; also a switchgear unit. You are invited to write for descriptive bulletins.

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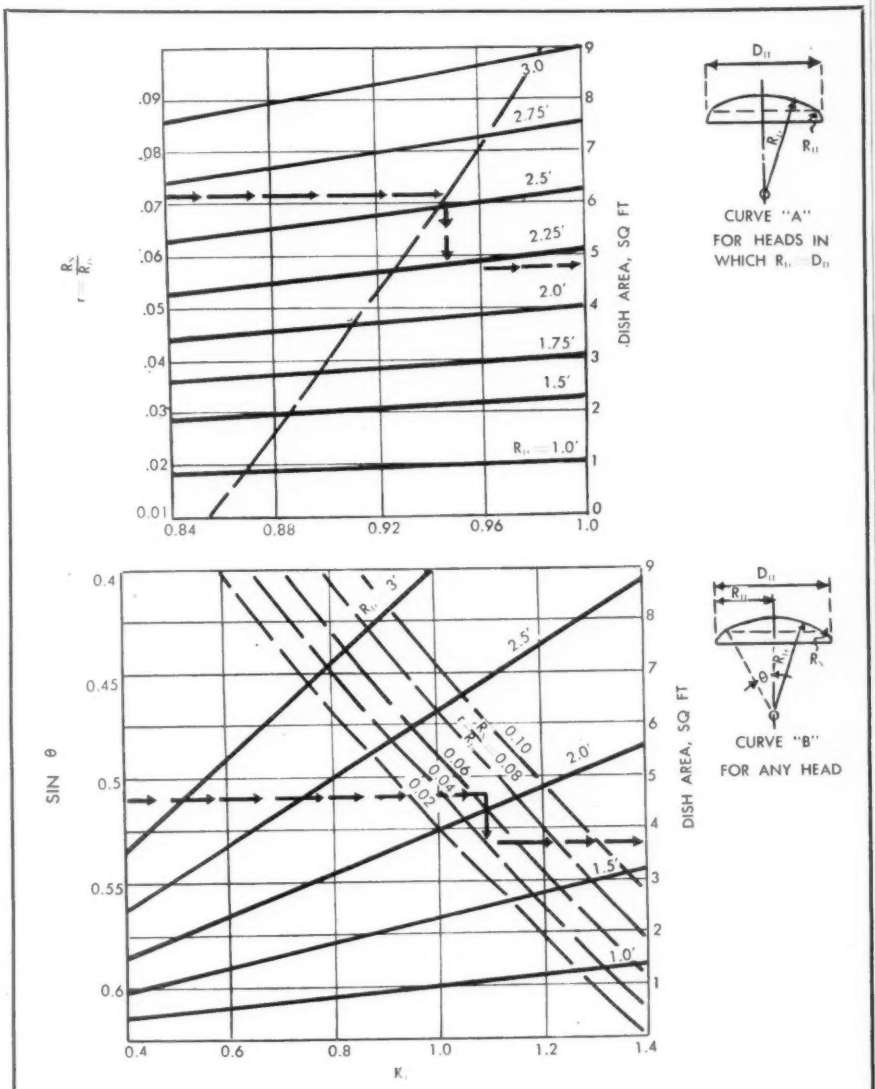
CHARTS FOR DISHED HEAD AREAS

IN material cost estimates, pressure vessel design, and determination of weights of tanks, the area of a dished head is often required. Standard tables of tank dimensions do not contain this information. As a result the area must be computed. The curves shown simplify these calculations.

Example 1: Find the area of a 27-in. diam dished head when the knuckle radius is $1\frac{5}{16}$ in. and the dish radius 27 in. The ratio, $r = \frac{RN}{RD} = \frac{1.9375}{27}$ $= 0.0714$. Since dish radius equals head diameter, enter curve "A" at $r = 0.0714$ and project across horizontally until the dashed curve is intersected. From this point vertically to the 2.25-ft dish radius curve and run across horizontally and read 4.8 sq ft.

Example 2: Find the area of a 24-in. dished head which has a 22-in. dish radius and a 1½-in. knuckle radius. The ratio, $r = \frac{1.50}{22}$ 0.068 and $\sin\theta = \frac{R_H - R_N}{R_D - R_N} = \frac{12 - 1.50}{22 - 1.50}$ $= 0.51$. Since $R_D \neq R_H$, curve B must be used. Enter at $\sin\theta = 0.51$ and project horizontally across to a dashed curve, $r = 0.068$, lying between $r = 0.06$ and $r = 0.08$. From this point drop vertically to the dish radius of 1.83 ft and then run across to the area, 3.7 sq ft.

When the dish radius is greater than the values covered by these charts, head area can be found from $A_H = K\,(R_D)^2$ and $A_H = K_1\,(R_D)^2$. The constants K and K_1 appear at the bottom of the charts A and B, respectively.



Curve A, top, for heads in which $R_D = D_H$.

Curve B, bottom for any head.

Derivation of Chart

Chart A is based on the relation

$$A_H = KR_D^2 = 2\pi\left[\, r\left\{\frac{\pi}{2}(1-r)\sin\theta - \theta\,(1-r)\sin\theta + r\cos\theta\right\} + (1-\cos\theta)\right] R_D^2$$

Chart B is based on the relation

$$A_H = K_1R_D^2 = 2\pi\left[\, r\left\{\frac{\pi}{2}(1-r)\sin\theta - \theta\,(1-r)\sin\theta + r\cos\theta\right\} + (1-\cos\theta)\right] R_D^2$$

Both relations can be derived using calculus. What the charts do is to reduce the long geometric expressions to simple constants which are easy to apply.

Constants K and K_1 were obtained using API-ASME dished head standards. Two curves were used to simplify the calculations for each type of head. * * *

LAUGH WITH BARNEY

Around midnight, the absent-minded professor left his berth in the sleeping car for a drink of water. Upon his return, he found that he was lost. He appealed to the porter for help.

"Don't you remember the number of your berth?" the porter asked.

"I'm afraid not," replied the professor.

"Haven't you any idea where it was?" asked the porter.

"Why, yes," the professor brightened, "to be sure. I did notice one time this afternoon that the window looked out on a little lake."

* * *

A feminine passenger had boarded the bus after the lights had gone out. A tall man standing near her asked if he could help her find a strap.

"Thank you," she replied, "but I have already found one."

"Then I wonder if you would mind letting go of my necktie?"

* * *

Ann: "What can a bird do that 7 out of 10 people can't do?"

Dan: "Make a small deposit on a new car."

* * *

A human being is a chap who'll split his sides over the family album and then look into the mirror without cracking a smile.

The lunatic, after a very exemplary record of sanity was dicharged from the asylum and returned home. On the following morning he decided to shave as every sane man does. He nailed the mirror to the wall, stood before it lathered his face, then selecting an old fashioned razor, proceeded to shave; at this moment the nail slipped, and the mirror fell to the floor. He stood gazing, the blank wall before him, then remarked bitterly. "Just my luck! Second day out and I've cut my blooming head off!"

* * *

Jim: "There are sure a lot of freak accidents in bad storms, aren't there?"

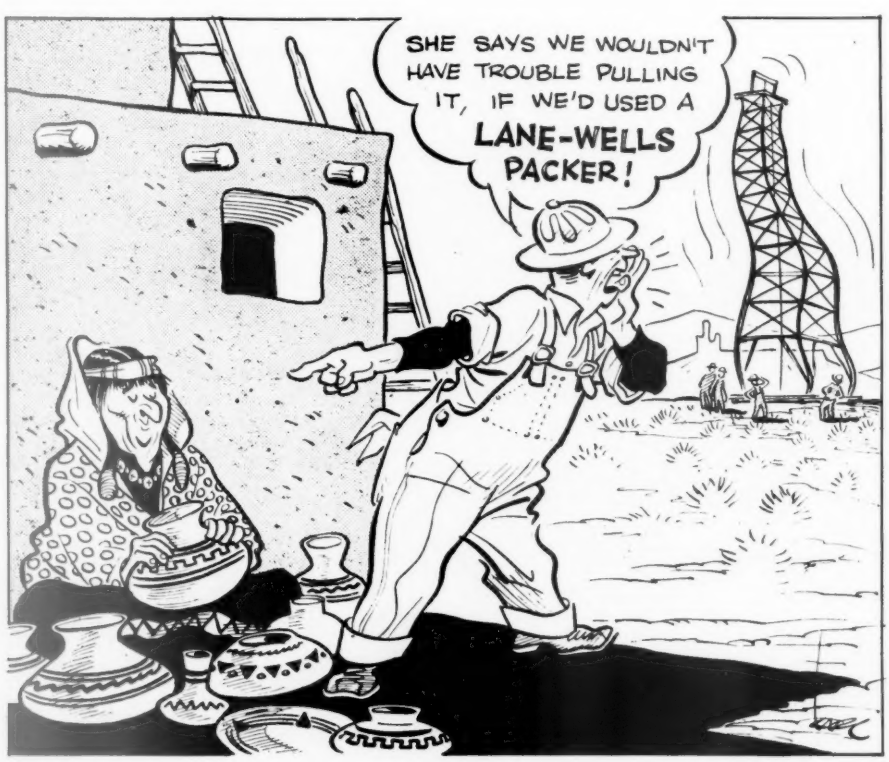
Bill: "Yes, did you hear of the hen standing with her back to the howling wind of a tropic storm? She laid the same egg six times."

* * *

A lady was riding on the train with her son. When the conductor came by she said, "A fare for one and a half fare for the boy."

The conductor looked at the boy and said, "Lady, that boy's got long pants on."

"In that case," said the lady, "full fare for the boy and half fare for me." And the colored woman sitting behind said, "Bless my heart, I goes for nuffin!"



The new doctor was the only one available in town when Mr. Kelly's wife was taken ill. Called to the Kelly home, he went upstairs to the sick room but came down in a few minutes to inquire of Kelly, "Have you a corkscrew handy?" Given the tool, he disappeared up the stairs for the second time.

Several minutes later the doctor was back. "Got a screw driver?" he asked the anxious Kelly. Instrument in hand, he went upstairs again.

Almost immeditely he was downstairs again. "A chisel and mallet, quickly," he demanded. The distraught husband could stand it no longer. "For the love of Heaven, doctor," he begged, "what's the matter with my wife?"

"Don't know yet," was the reply. "Can't get my medicine bag open."

* * *

A small-time salesman treated himself to a ride from Boston to New York on the Millionaire's Special. Thrilled by the train's luxuries, he finally entered the club car where Wall Street Midases were discussing business.

"A bad week," he heard one capitalist complain. "We netted only $130,000."

"It was better for us," said another. "Wheat was hot and we cleared $250,000."

Man after man told of such profits. Suddenly, all eyes centered on the little salesman and someone asked, "How's your business?"

"So-so," he shrugged. "Last week yellows were off half a million, but reds were up a million, and blacks up four million."

Eyebrows raised in wonder. Then one Midas respectfully asked, "What's your business?"

"Me?" sighed the salesman. "I sell jelly beans."

* * *

Clerk—I'll have to have a raise in salary — three other companies are after me.

Boss—Is that so? Who are they?

Clerk — The light company, the phone company and the water company.

* * *

A salesman taking his bride south on their honeymoon visited a hotel where he boasted of the fine honey served there.

Salesman (to colored waiter): "Sam, where's my honey?"

Negro (eying the woman cautiously): "Ah don't know, boss. She don't work here no mo'."

OIL AND GAS TRADE NEWS

Continental Sales Force Holds Annual Sales Meet

The Continental Supply Company, Dallas, Texas held its annual sales meeting recently at the Baker Hotel in that city. In addition to Continental officials and sales representatives from all divisions and offices, the meeting was attended by executives of Youngstown Sheet and Tube Company, Emsco Derrick and Equipment Company, and other associated companies. One of the features of the convention was a group meeting of Continental personnel only at which time officials of associated manufacturers appeared individually and discussed new products and sales techniques.

Sessions were conducted by Fredrick M. Mayer, president; Frank I. Brinager, executive vice president; and Jack A. Mussler, manager of sales, all of Continental. Those from Youngstown included Walter Watson, 1st vice president and J. L. Mauthe, vice president. Emsco was represented by Hugh Glenn, president, and vice presidents W. L. Powell, Bill Kinder, and C. L. Lamkin.

Features History of Harley Sales Company

The March issue of *Enginews* featured the Harley Sales Company of Tulsa, Oklahoma, which has been distributors of Wisconsin Motor Corporation engines since 1936.

Harley Sales began when Roy and Harley Neal, engaged in engineering work for an Oklahoma gas and electric utility, came in contact with the Wisconsin motors, and gained distributorship for Oklahoma. In 1944, the company suffered its first major misfortune in the sudden death of Harley B. Neal. Harley was well experienced, and a major force behind the company. He was aptly succeeded by his brother Roy, however, who became president of the firm. Three generations of Neals are active in Harley Sales: Harry B. Neal, father of both the late Harley Neal and Roy Neal, president; newest member is Bob R. Neal, son of Harley Neal. Latest Harley branch is the 8000 sq ft sales and service unit opened recently in Wichita, Kansas.

Fix Company Sets Up Houston Branch Office

The George J. Fix Company, 2413 Commerce Street, Dallas, Texas has announced the opening of a branch office of the firm in Houston. The Houston branch is situated at 2702 Polk Avenue. L. R. Scaff is in charge of the new Houston office.

The Fix Company offers complete lines of mechanical power transmission and material handling equipment as representatives and distributors. Manufacturers represented include Boston Gear Works, Allis-Chalmers Manufacturing Company, Robbins and Myers, Inc., Baldwin-Duckworth division, Chain Belt Company, and the Reeves Pulley Company.

DGE Observes 25th Year

Dozier-Graham-Eastman, industrial advertising agency, celebrated its 25th anniversary last month. During its 25 years, DGE has progressed from a small, one-man operation to a large organization, handling a wide cross section of industrial and consumer accounts.

M. M. Dozier

C. D. Graham

S. C. Eastman

The more than 60 accounts served by Dozier-Graham-Eastman represent virtually every phase of industry found in the West. They include companies that serve such diversified industries as oil well drilling, producing and refining, paper and pulp mills, water and sewerage treatment, etc. Of the more than 62 clients, over two-thirds have been clients for periods of from 10 to 20 years, the agency stated.

Attending Continental Supply Company's annual sales meeting in Dallas recently, were company officials and sales representatives from all divisions and offices and executives from associated companies.

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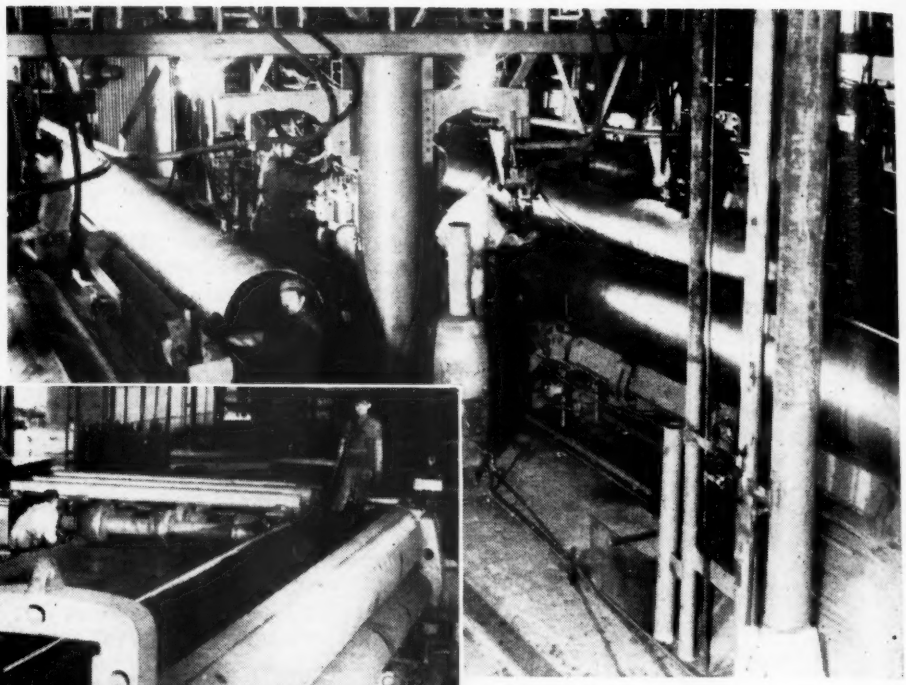
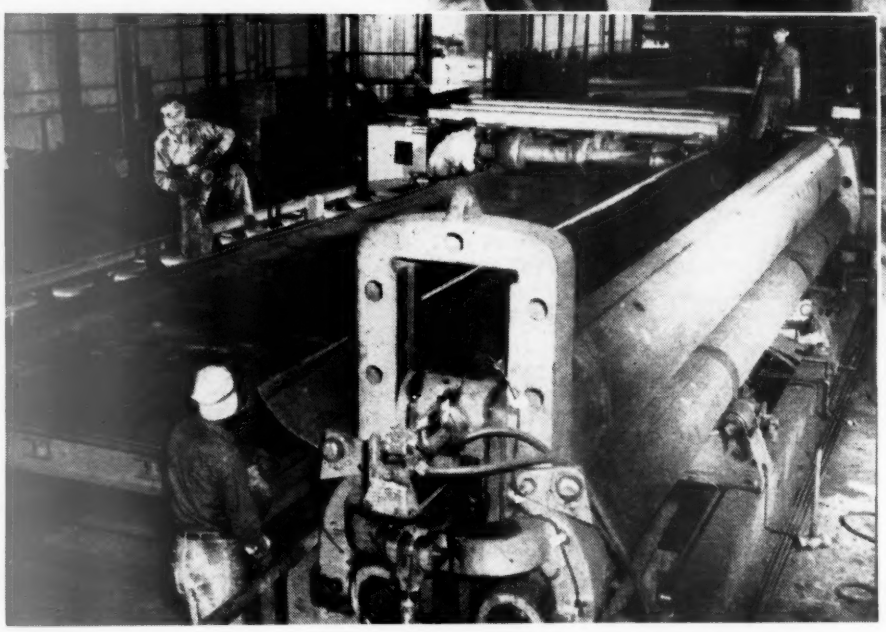


Submerged arc welding along entire length of pipe, right, and below are bending rolls that handle sheet steel from 26 to 36 in. in width and up to 31 ½ ft long.



Big Pipe Rolls Off Line of Southwestern Factory

A mile or more a day of steel pipe as large as 36 in. in diam rolls out of a big capacity fabrication plate that is one of the nation's youngest—Master Tank and Welding of Dallas, Texas.

Master's is the first pipe producing establishment to be situated in the Southwest. Sam O. Weempe, partner and general manager of the firm, received an order from Lone Star Gas Company for 75 miles of 20-in. pipe in the summer of 1948. Master Tank and Welding was then primarily in the business of making pressure tanks for liquefied petroleum gases. Weempe delivered the 75 miles, plus another order from the Lone Star Gas Company for 50 more miles. To do it, he had to construct a pipe manufacturing plant. Now in full blast operation, it continues to serve the gas and oil industries.

Hardly touched by human hands, sheet steel from ¼ to ½-in. in thickness and in slabs weighing as much as two tons is fed to the Master Tank and Welding production line with the casualness of dropping nickels into a gum machine. Through crimping, rolling or pressing, welding, straightening, beveling and hydrostatic testing and expansion the pipe continues with mechanical guidance to a 100-mile capacity storage yard.

Actually, Master Tank and Welding's pipe-forming facilities consist of two complete pipe mills. The No. 1 pipe mill, completed late in 1948, is equipped to produce pipe by the "press" method from 20 in. to 24 in. in diam and in lengths up to 30 ft. The No. 2 pipe mill was erected late in 1949 to manufacture pipe by the roll process from 24 in. to 36 in. in diam in lengths up to 31½-ft sections or double-jointed lengths up to 63 ft requirements.

The two complete plants mean that Master can handle two separate contracts at the same time. Their present production is around 1¾ miles a day.

The pipe press in the No. 1 plant is unusual in having a 30-ft distance between housings. Weempe and his engineers built the press rather than wait for a manufacturer to deliver it. The Weempe-designed giant has a unique 75,000-lb top beam that will form one 30-ft pipe section every minute. The press is hydraulically operated, driven by one 400 hp electric motor and one 535 hp diesel motor.

Each piece passes through a series of rigid inspections. Master's automatic welding machines employ the submerged arc process. Costly X-Ray equipment helps check for flaws, and at the end of the assembly line the pipe is placed in a hydraulic expander and pressure-tested to 2500 psi or more.

Master has the authorization of the American Petroleum Institute to mark the Institute's official monogram on high-test line pipe in accordance with API 5LX, Certificate Number 1055.

The present company formally dates from 1941 when it was set up by Weempe. There now are more than 200 employees and gross business runs into the millions of dollars annually. ★ ★ ★

Where resistance to HIGH HEAT is essential . . .

GUN IRON CASTINGS

Where cast parts are subjected to high temperatures, Gun Iron and its alloys provide ideal properties. Basic Gun Iron maintains full tensile strength and hardness up to 850° F. and loses only 12% of strength at 900° F. By use of proper alloys this ceiling can be raised to 1000° F. In addition, growth is negligible up to 800° F. and amounts to only ¼ of 1% in linear dimensions at 900° F.

This unusual property of Gun Iron has solved many problems for users of industrial castings subjected to prolonged heats. Combined with superior resistance to frictional wear, erosion and corrosion, impact and pressure, it completes the requirements necessary for an iron that will give outstanding performance on the toughest casting assignments . . . and that is just what Gun Iron has been doing for over 139 years.

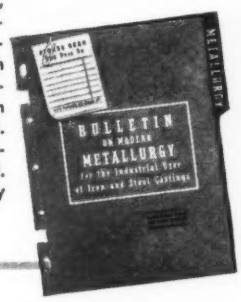
If these properties look like they can solve a design or maintenance problem for you, why not drop us a line. Our engineers, metallurgists and unexcelled laboratory facilities are at your disposal to help determine the specific economies of Gun Iron for your application.

GUN IRON *in the* PETROLEUM INDUSTRY

Hunt-Spiller casts and machines many parts for the petroleum industry. A few are listed below:

LINERS, PISTONS AND RINGS FOR HOT OIL PUMPS • BUBBLE CAPS AND TRAYS • TUBE SUPPORTS • PRESSURE CASTINGS

Chances are that there are many other places where Gun Iron can solve a design or operating problem. To help you determine the value of Gun Iron for your cast parts, our metallurgical department has prepared a comprehensive bulletin which contains complete properties and discussions of Gun Iron and many other metals. Engineers claim it an invaluable reference aid. Send for your free copy today.



HUNT-SPILLER GUN IRON • HSGI • AIR FURNACE PROCESS

HUNT • SPILLER

MANUFACTURING CORPORATION

377 DORCHESTER AVENUE • SOUTH BOSTON 27, MASS.

Canadian Representatives: Joseph Robb & Co., Ltd., 4050 Namur St., Montreal 16, P. Q.

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GO DOWN

When You Rely On

SAND-BANUM

To Safely Remove and Prevent Rust and Scale

"STANDARD" Can-in-Hand for Boilers

"SPECIAL" Tablets-in-Tubes for Radiators

SAND-BANUM
SAND-BANUM SPECIAL
Removes old SCALE and RUST from radiators water jackets and all parts of cooling system. Also PREVENTS formation of new SCALE or RUST
AMERICAN SAND-BANUM CO. Inc.

Sand-Banum Special in Tablet form Solves the Scale Problem in ALL Radiator Cooling Systems.

Sand-Banum Standard is in its 24th Year of World-Wide Power Plant Service.

WRITE NOW
For Performance Proof.

Carried in Stock by Leading Supply Houses

AMERICAN SAND-BANUM CO.
Established 1926
9 Rockefeller Plaza
New York 20, N.Y.
SAND BANUM

Natural Gas Equipment's new offices in Pasadena, California.

NGE Gets New Offices

Natural Gas Equipment, Inc., has moved its offices to 190 East Glenarm Street, adjacent to the Arroyo Seco Parkway, Pasadena 2, California. In its new location the company has not only obtained increased office space but also ample warehousing facilities. The new structure occupied by NGE is a two-story building containing approximately 7000 sq ft and is served by a spur of the Southern Pacific Railroad.

Natural Gas Equipment has recently acquired representation in California, Oregon, Washington, and Arizona for the products of the Valve and Primer Corporation, Chicago.

Shows Microwave System

Motorola Inc. showed what it claims is the smallest microwave system in the world at the Petroleum Industry Electrical Association convention in Houston, Texas recently.

The unit made use of five regular sub-channels impressed on one carrier frequency. This included four telephone channels, and a supervisory and telemetering control channel for operation of distant equipment. Eight different channels were demonstrated by use of this equipment at the convention. The major operation was the opening and closing of a 3-ton valve of the type used in the oil and gas industries.

A group of Whitmor houses that can be moved to oil fields for workers' homes.

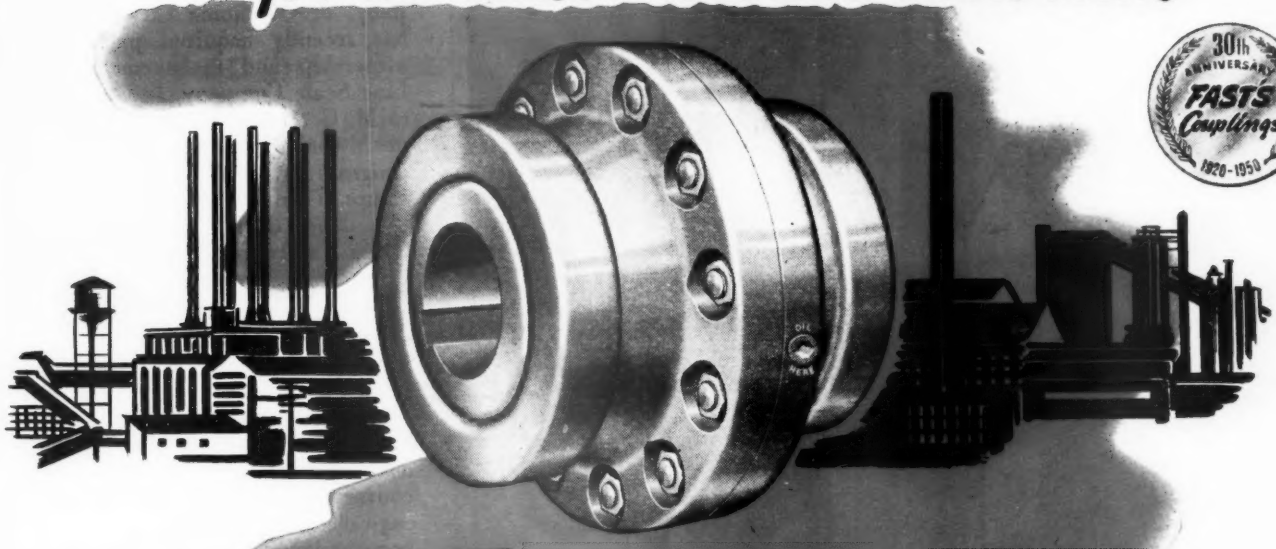
Whitmor Recognized For Distinctive Field Housing

Whitmor Homebuilders was organized when M. W. Turner Company of Tulsa, Oklahoma bid on a field housing project during the war. In the beginning, Whitmor found housing problems in the oil field enormous. Building and material costs put individual and distinctive houses beyond the reach of oil company field housing budgets. The answer to the problem was to utilize power machinery, trained crews, mass production methods, and above all, quantity buying.

Whitmor homes are offered on two purchase plans—they can be purchased outright or rented on a lease plan. An entire field project, including tool buildings and warehouses, can be put on one purchase order. Whitmor's facilities make it possible for them to build anywhere in the Mid-Continent area.

M. W. Turner is president, Burl Johnson is vice president, Russell Renfrow is production superintendent, and field superintendents are Thurman Everett, Cecil McIntyre, Harper Wicker, Gilbert Moronney.

you can FORGET COUPLING SHUTDOWNS—



INDUSTRY REPORTS—

KOPPERS ENGINEERING STOPS COSTLY FAILURES

In oil fields, steel mills, power plants . . . all through industry . . . cost-wise executives report that *Fast's Couplings,* designed, manufactured and guaranteed by Koppers, are the best insurance against coupling failures! Take a tip from these users who know. Specify Fast's and forget *your* coupling problems!

By specifying Fast's, you get the benefit of Koppers Engineering Service, acknowledged best in the industry. Koppers Engineers, backed by 30 years coupling experience, study your problem . . . then show you *which* Fast's Coupling fits your application, (and more important) *why* you need it!

Only Koppers can offer you this valuable service . . . : only Koppers offers Fast's, the original gear-type coupling. Fast's Couplings assure you freedom from expensive coupling failures in your plant because Fast's have no perishable parts to fail!

GET THE FACTS: Mail coupon today for your free copy of the Fast's Coupling Catalog, published by Koppers. Shows how Fast's operate, describes the many sizes and types. Gives full details about Koppers Engineering Service. Send for your copy today.

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . *Koppers Engineers are acknowledged the best in the coupling industry. Their practical knowledge, backed by 30 years of coupling experience, is at your service!*

IMMEDIATE DELIVERY . . . *All standard types and sizes are available for immediate delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!*

LOWEST COST PER YEAR . . . *Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!*

KOPPERS

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

FREE CATALOG

KOPPERS CO., INC., *Fast's Coupling Dept.,*
266 Scott Street, Baltimore 3, Md.:
Please send me a free copy of your Fast's Coupling Catalog.

Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

TM Alloy Steel Spinning Chain is *tougher* and harder than conventional Hi-Test types. Its greater resistance to wear — plus its greater strength and longer life means lower spinning chain costs. Short links assure better grips. Complete heat-treatment — in modern furnaces — means uniformity in every link. Also available in TM Hi-Test grade. See your nearest oil well supply store for details on these and other TM Chains for hold-downs, snake-ins, rigging and the complete line of TM Tire Chains.

S. G. TAYLOR CHAIN CO., HAMMOND, INDIANA

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

M-C-M Acquires Stock

The M-C-M Machine Works Company, of Oklahoma City, Oklahoma has recently acquired partial stock ownership and management of the Line Scale Company, Inc., according to M. G. McCool, one of the owners of M-C-M. An extensive expansion program is anticipated in the near future. This will include considerable remodeling of the present plant to increase and modernize production facilities.

Dearborn Adds Agents

Dearborn Chemical Company has announced the addition of twelve new representatives to its sales and service staff. These men recently completed an intensive seven week training course conducted in Dearborn's Chicago offices and laboratories and have been assigned to these territories.

T. Armstrong, West Texas and New Mexico, headquarters in Amarillo; R. W. Bartlett, New England, headquarters in Boston; C. P. Blakeley, New Jersey, headquarters in New York City; T. Bull, Northern California, headquarters in San Francisco; J. W. Fisher, Eastern Ohio, headquarters in Cleveland; R. E. Johnson, Northern part of the city of Chicago; W. J. Mercier, Southern Wisconsin, headquarters in Milwaukee; R. T. Moran, part of Michigan with headquarters in Kalamazoo; D. E. Pedginse, Northern Indiana, with headquarters in South Bend; H. O. Scott, Central Ohio, headquarters in Dayton.

Two men have also been added to Dearborn's technical department in the Chicago office. V. P. Nobile will assist E. M. Welch, manager of Dearborn's industrial water treatment department and K. W. Franks will assist J. F. Wilkes, technical director of Dearborn's railroad department.

Open English Branch

Fisher Governor Company, Marshalltown, Iowa, manufacturers of pressure and liquid level control equipment, is now manufacturing controllers and regulators in Great Britain. Address of the new office and plant is Fisher Governor Company, Ltd., Lewisham, London S.E. 13, England. Equipment of Fisher Governor Company carries the Fisher trademark and is built to the same specifications and standards as that made in the U.S.A.

Products marketed by Fisher Governor Company, Ltd., are being manufactured by Elliott Brothers (London) Ltd. J. W. Fisher, executive vice president, and P. A. Elfers, vice president and sales manager, returned from England recently after completing arrangements with Elliott Brothers.

"Cylinder lacquer is a costly condition that frequently develops. Lacquer prevents rings from maintaining proper contact with the cylinder wall and results in blow-by, impaired cooling, loss of cylinder pressures, improper combustion, and waste of fuel. It adds to operating costs. It creates extra maintenance problems.

"When Cook engineers encounter such a problem, they first determine the cause. Second, they suggest a remedy. Third, they recommend the most efficient ring combination for the particular operating requirements.

"Cook calls this service 'job-engineering' because it puts ring selection on a sound and scientific basis. Cook can do it because it has on hand a mass of data obtained from electronically indicating engines under all service conditions. Cook knows what to look for—knows what to expect—and knows how to correct it."

It will pay you to have Cook make a "job-engineered" survey of *your* ring requirements. There's no obligation.

C. Lee Cook Mfg. Co., Incorporated, Louisville, Kentucky. Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK GRAPHITIC IRON
PISTON RINGS

. . . SEALING PRESSURES SINCE 1888 . . .

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Schlarb Tours U. S.

H. J. Schlarb, assistant sales manager, Chiksan Company, Brea, California, recently returned from an extensive trip throughout the United States. In addition to calling on Chiksan representatives and users, Schlarb visited industrial, processing, aircraft, paper, textile, food, automotive, and other types of plants in all sections of the country.

"In the majority of the plants visited," says Schlarb, "production is being maintained at capacity and plans for development and expansion are going forward on schedule." He added that a warehouse stock of Chiksan and Weco products and Okadee loading rack valves has been established in Newark, New Jersey to render prompt service to Chiksan customers.

Welex Opens Field Station

Welex Jet Services, Inc. has opened a new field station at Snyder, Texas, with J. E. Sherrod as operations manager. Sherrod has had extensive experience in jet perforating and other well servicing operations. He joined Welex in 1948, and worked from the field station at Odessa until promoted to manager of the Snyder station.

Why CARLON Plastic Pipe will move more fluid for less money

CARLON is practical for—

When all factors are considered, Carlon Plastic Pipe will reduce transmission costs. The dense smooth internal surface of plastic pipe reduces friction between fluid and walls, and less fluid turbulence is created by internal surface irregularities.

Less semi-solids adhere to internal walls, so full line capacity is utilized. This decreases pressure losses from internal obstructions.

Actual tests proved that head loss is much less in Carlon Plastic Pipe. In many cases a smaller diameter plastic line will carry the same volume of fluid as a larger diameter conventional line.

- DISPOSAL TUBING
- GATHERING LINES
- WATER LINES
- SIPHON LINES
- LEAD LINES
- GAS LINES

WRITE FOR COMPLETE INFORMATION

GREEN CONTRACTING AND ENGINEERING CO., INC.

103 SOUTH VINE . . . WICHITA, KANSAS

CARTER PRODUCTS CORPORATION, CLEVELAND, OHIO, MFRS.

Du Pont To Build New Unit

Plans for construction of a new unit at Camden, South Carolina, to manufacture "Orlon" acrylic fiber in staple form have been announced by E. I. du Pont de Nemours and Company. "Orlon" is du Pont's newest synthetic textile fiber.

The new plant will be a separate unit to be constructed at Camden next to the plant being built for manufacturing "Orlon" in the form of continuous filament yarn. Research on the staple process is being increased from a laboratory-scale operation to a pilot-plant operation at the company's Waynesboro, Virginia, research laboratory.

Employent at the Camden plant is expected to be increased by approximately 1000 new operating jobs.

Doremus To Head New York Branch

Thomas Bryan and Associates, Inc., of Houston, Texas, engineers and constructors, have announced the opening of their New York branch office with Rodman B. Doremus of Greenwich, Connecticut, as manager. This company's business in the North East will be handled by Doremus.

A construction and engineering consultant since his resignation in 1948 as executive vice president of F. H. McGraw and Company, Doremus will give his full time to Thomas Bryan and Associates, Inc. business who will continue to maintain their main offices and activities in Houston.

Chiksan Names Agents

Robert S. Hudgins, Jr., Charlotte, North Carolina, will cover North and South Carolina for Chiksan Company, Brea, California. The Southern Corporation, Charleston, South Carolina, will continue to represent Chiksan in the pulp and paper industry in these states. R. S. Stover Company, Kresge Building, Marshalltown, Iowa, has been appointed to cover the states of Iowa and Nebraska.

GAS ENGINEER WANTED

By consulting engineering firm located in New York City. Applicant should have had experience with either transmission or distribution of natural gas. Analytical ability desired in connection with certificate and rate work. Age 35-45. Reply, giving age, education, experience, references and salary required. All replies kept confidential. Write Box 110, care The Petroleum Engineer, Box 1589, Dallas, Texas.

SALES REPRESENTATIVES

Soundly established, progressive firm has openings for three district sales representatives. Experience in pipe, valves or fittings an asset. Excellent opportunity. Write Box 109, care The Petroleum Engineer, Box 1589, Dallas, Texas, stating complete, detailed background. All communications confidential.

TRADE PERSONALS

D. M. Bailey was recently elected vice president in charge of finance of The Continental Supply Company, Dallas, Texas. Bailey has been serving

D. M. Bailey

C. L. Vickers

as general counsel and will continue to hold that office. With Continental since 1931, he has spent his entire business and professional career with the organization. Beginning as assistant general counsel, he was made general counsel in 1936, and elevated to assistant vice president in 1948. From 1942 to 1945, Bailey served as a major in the Army Air Corps.

C. L. Vickers was elected treasurer of Continental. He joined Continental in 1930 at Houston, Texas as a credit clerk, and has been successively promoted to district credit manager, credit manager, and assistant treasurer. He continues to hold the position of credit manager.

William W. Jamieson was appointed vice president of industrial sales and **Lewis C. Blackhall** was appointed an assistant vice president of Dearborn Chemical Company, Ltd., Toronto, Canada.

Jamieson joined Dearborn in 1922, became a sales representative and in 1946 was promoted to sales manager, industrial water treatment sales. Blackhall has been with Dearborn since 1937, and has served as sales manager, industrial NO-OX-ID department.

Paul Courtney, manager of Emsco's Houston plant operations, was appointed vice president of Emsco Derrick and Equipment Company at the directors' meeting in Los Angeles, California, recently. Courtney has traveled extensively in the interests of Emsco in both domestic and foreign fields. He has been with Emsco since 1938.

Also appointed at the directors' meeting was **A. H. Miller,** who was named secretary and treasurer of Emsco Derrick and Equipment. Miller has been with Emsco for 21 years and was secretary and assistant treasurer before his new appointment.

Richard H. Olson, formerly vice president in charge of sales, has been elected president of Electric Machinery Manufacturing Company, succeeding **Walter H. Feldmann,** who has resigned to assume the office of vice president in charge of sales of Worthington Pump and Machinery Corporation, Harrison, New Jersey. The Electric Machinery Manufacturing Company will continue to operate as in the past as a wholly owned subsidiary of Worthington Pump and Machinery Corporation.

B. M. Brown has been appointed manager of special accounts for the Westinghouse Electric Corporation. In his new position, he will coordinate sales negotiations in cases where a customer's requirements cut across regularly established sales responsibilities in the Westinghouse organization.

Since July, 1948 Brown has been assistant manager of the Westinghouse transportation, marine, and aviation sales department. A graduate of the University of Illinois, he joined Westinghouse in 1931.

W. O. Brady has been appointed to the sales force of Rockwell Manufacturing Company, Pittsburgh, Pennsylvania. He will cover the state of Alabama and handle the meter, regulator, and valve lines of the Pittsburgh equitable meter and Nordstrom valve divisions of Rockwell.

H. H. Peters

H. H. "Pete" Peters, vice president of Technical Oil Tool Corporation, Ltd., reported back in Los Angeles, California after his first 1950 intensive survey of Mid-Continent and Rocky Mountain fields. During the month's trip, Peters and **E. G. McConnell,** Mid-Continent sales manager for Totco, held meetings in Shreveport, Houston, Odessa, Oklahoma City, and Denver with Totco representatives from the surrounding territories.

Reviewing the company's expanding sales program with each group, Peters discussed new equipment under development, field test results, service improvements, and the functioning of Totco's expanding field service organization.

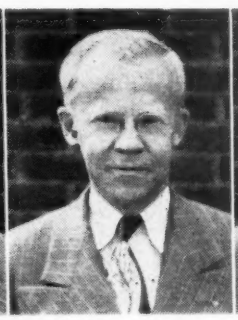
C. D. Conklin has been appointed manager of The Continental Supply Company branch at Casper, Wyoming.

E. V. Frames was made manager of the company's Houma, Louisiana, store. He was formerly field salesman at that plant.

Henry W. Beck has been appointed advertising manager of Airco Company International. He was formerly assistant manager, advertising department for Airco-Magnolia Company. Both companies are divisions of Air Reduction Company, Inc. Beck has been with the Air Reduction organization over 20 years.

C. E. Whittaker

T. R. Ashe



D. M. Whipple

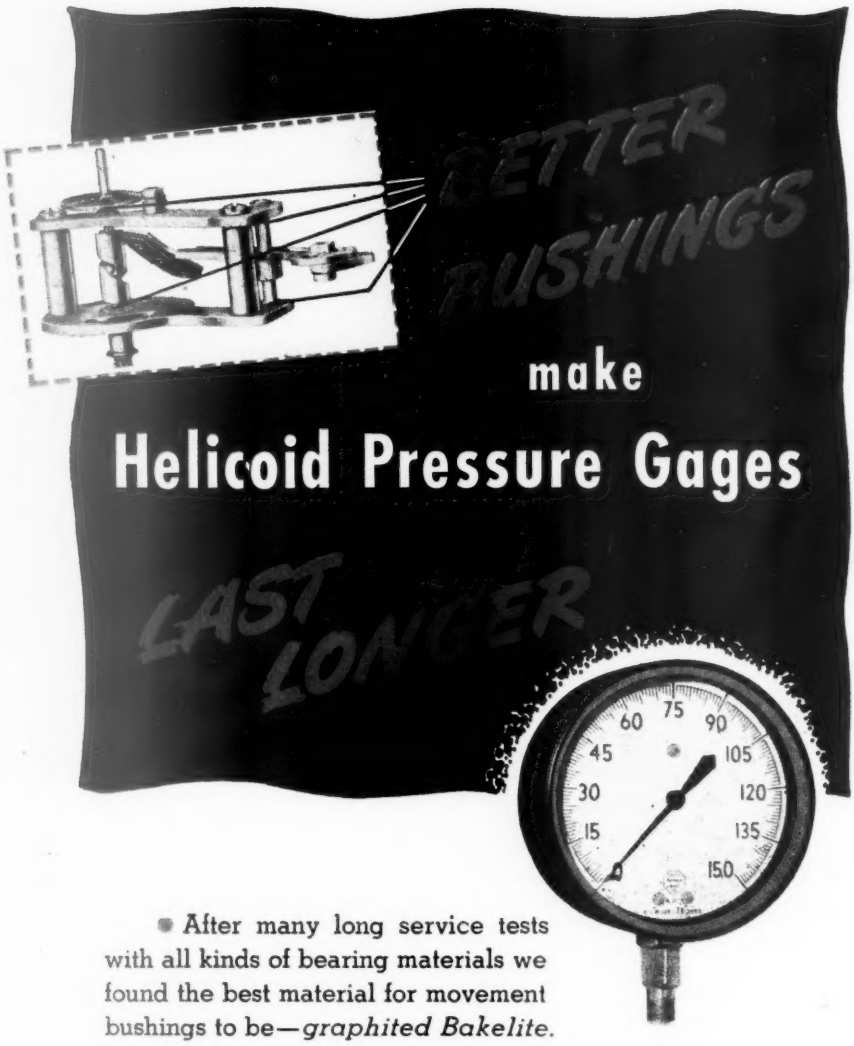
J. S. Goodwin

Charles E. Whittaker has been elected president of Globe Oil Tools Company, succeeding the late E. M. Smith. Whittaker, who also retains his former title of general manager, has been with the company since it was formed more than 20 years ago, and has worked his way up through the ranks.

Succeeding to Whittaker's former position of vice president, is **Thomas R. Ashe,** who also was elected assistant general manager. Ashe, a graduate of Notre Dame University, has been with Globe since 1934.

Donald M. Whipple retains his post as secretary-treasurer, a position he has held for the past three years. Prior to joining Globe, he was with Diederick Optical Company of Los Angeles. **John S. Goodwin** has been head of the Globe engineering department for 10 years. He is a graduate of California Institute of Technology.

XUM

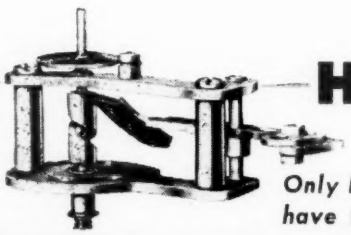


● After many long service tests with all kinds of bearing materials we found the best material for movement bushings to be—*graphited Bakelite.*

Graphited Bakelite bushings outwore all others—ran 50,000,000 full stroke cycles at 700 cycles a minute with negligible wear, no corrosion, no distortion from impact.

Among other tests, one of the largest public utilities found that HELICOID GAGES with these bushings lasted four times longer than any other gage tested under the same severe conditions.

Helicoid movements with graphited Bakelite bushings have less static and kinetic friction. They are now standard in all Helicoid gages—at no extra cost.



HELICOID

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ACCO

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HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

▸ **Harold J. Bordelon** has been promoted to advertising supervisor of The Fluor Corporation, Ltd. He succeeds **Jack E. McKay,** who has assumed the duties of sales engineer in Fluor's Houston, Texas sales office. Bordelon has been associated with the company for the past eight years and was formerly assistant advertising manager previously connected with Fluor-o-Scope, the company employe magazine.

A. H. Brodie

▸ **Arthur H. Brodie** was recently named district manager of Tube Turns of Canada Limited. His headquarters will be at the company's plant in Chatham, Ontario. During World War II Brodie served in the Canadian Army, first in the ordnance corps, then with the 48th Highlanders. He joined Tube Turns of Canada Limited on March 16 of this year.

▸ **C. O. Long,** sales representative for The Guiberson Corporation in West Texas, passed away in a San Antonio hospital recently. Long had been in the employ of The Guiberson Corporation since 1944. Prior to 1944 he had been employed as a drilling superintendent operating in the West Texas area.

▸ **William T. Hack** was appointed manager of the product development department of Ethyl Corporation, recently. A former member of the product development staff, he first joined Ethyl in 1946 and resigned two years later to accept appointment as director of the chemical and rubber division of the National Security Resources Board, Washington, D. C.

For six years prior to the war he was an engineer with the Carbide and Carbon Chemical Corporation, South Charleston, West Virginia.

▸ **A. J. Edgar,** general manager of Hunt-Spiller Manufacturing Corporation, Boston, Massachusetts, producers of petroleum field castings in iron and steel, has been elected a vice president. N. C. Raymond, president of the 140-year-old company, made the announcement.

▸ **C. W. (Bill) Moyer** has been appointed division manager, oil field sales, for Altens Foundry and Machine Works, Lancaster, Ohio. Moyer, who has been special sales representative for the past two years, will direct all national sales of Alten equipment to supply stores and assist Alten dealers with their merchandising activity.

▸ **T. W. Thurmond, Jr.,** formerly local representative for Bethlehem Supply Company, at New Orleans, Louisiana, has assumed the duties of oil field engineering representative for Bethlehem Steel Corporation with headquarters in New York City. Thurmond is a graduate of Oklahoma Agricultural and Mechanical College. He began work with Bethlehem as an engineering trainee.

K. G. Wagner has been employed and appointed store manager and field representative of the Corpus Christi, Texas store.

J. D. Reynolds, former floorman in the Kilgore, Texas, store, has been promoted to field representative and will assist in field sales work in the Kilgore area.

Clyde Ricks, formerly a floorman in the New Iberia, Louisiana, store, has been promoted to assistant store manager at that point.

▸ **Richard S. Harding** has been appointed manager of the Mid-Continent district, American Glycerin section of the du Pont Company's explosive department. He succeeds **Paul F. Lewis** who retired recently after 35 years service. A graduate of Wesleyan University, Harding joined the du Pont Company in 1930 as a chemist.

Lewis joined du Pont in 1915, and has been manager of the Mid-Continent district since 1929.

V. G. Ibert

▸ **V. G. Ibert** has joined the Cameron Iron Works, Houston, Texas sales department to specialize in the sale of the new Cameron non-lubricated lift plug (LP) valve. Ibert is well known among Gulf Coast refiners. He was previously employed as an operator at the Abercrombie-Harrison gasoline plant at Sweeney, Texas, and the Cities Service refinery and Cit-Con Oil Corporation at Lake Charles, Louisiana.

▸ **Joseph L. Stecher** has been appointed assistant sales director of du Pont Company's chemicals division. He was manager of petroleum chemicals production. **Emory M. Fanning** has been named assistant sales director of Kinetic Chemicals, Inc., manufacturer of "Freon" fluorinated compounds. He formerly was petroleum chemicals sales manager.

E. Hearn Simpson and **David H. Conklin** have been appointed sales managers of the division, Simpson to have charge of industrial sales, and Conklin to direct sales promotion.

▸ **Thad Randolph,** sales manager, Oil Base, Inc., has been transferred temporarily to the Mid-Continent to relieve **J. A. Moore,** Oil Base vice president, who returns to headquarters in Compton, California. Randolph will be stationed at the Dallas, Texas office of Core Laboratories, Inc., and will serve as liaison director between the two companies, helping with the training of Core Lab sales engineers in the use of Black Magic and Oil Base mud conditioning products.

▸ **J. M. Floyd,** who has been vice president in charge of manufacturing for the A. O. Smith Corporation, has been named executive vice president of the company. Floyd, in his new position, will take over general operating supervision of the company under the general direction of the president. He joined Smith in 1936.

▸ **A. F. Canada** has been named manager of centrifugal pump sales, of Pacific Pumps, Inc., Huntington Park, California, for the Mid-Continent area, with headquarters in Tulsa, Oklahoma. Canada joined Pacific in 1945 as Tulsa district manager. As Mid-Continent area manager, he will direct the sales of Pacific centrifugal pumps in the Rocky Mountain, Mid-Continent, and Gulf Coast Territories.

D. W. Conkling and **A. L. Anheier** have been named centrifugal pump sales engineers in the Tulsa office; and **W. L. Wathen,** centrifugal pump sales engineer, Houston office.

▸ **Dice Cowger** has been appointed district manager of the diesel engine department of heavy machinery division, Nordberg Manufacturing Company, Milwaukee, Wisconsin. Prior to his joining Nordberg, Cowger was a member of the sales force of National Supply Company, which he joined in 1947. From 1942 to 1945 he represented Busch-Sulzer Company in the New York office.

Following his schooling at Marietta College, Cowger began work for the Pure Oil Company.

▸ **C. Allan Fee** has been elected secretary of the American Car and Foundry Company, succeeding **Howard C. Wick** who is retiring after 45 years of service, the last 34 as secretary. Fee joined ACF in 1915, and was elected assistant secretary in 1938, holding this position until elected secretary.

▸ **Peter J. Fluge, Jr.** has been appointed advertising manager of the general products division of Owens-Corning Fiberglas Corporation replacing **S. J. Daly.** The Fiberglas account, which is handled by Fuller and Smith and Ross, Inc., was transferred from Chicago to Cleveland.

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P. I. Birchard

▸ **Paul I. Birchard** has been appointed vice president and general manager of Enterprise Engine and Foundry Company, San Francisco, California. Birchard has been identified with the diesel engine industry for over 20 years, and has been associated with Enterprise since early in 1946.

During the last war, Birchard served as a Navy commander in charge of a Midwest Navy shipyard. It was following this duty that he joined Enterprise as assistant to the executive vice president.

▸ **Alexander Toben,** formerly associated with Ledeen Manufacturing Company, Los Angeles, California, and most recently with Cardwell Manufacturing Company, is to take an active part in the sales and application design of Ledeen hydraulic and pneumatic actuating cylinders, as well as other equipment. He will also aid in introducing the new medium duty cylinder recently added to the Ledeen line.

▸ **Thomas B. Herndon** has been appointed development engineer of National Supply Company. He will make his headquarters at Fort Worth, Texas. His appointment will permit a close liaison between industry requirements and product development.

An engineering graduate from Rice Institute, Herndon came to National Supply in 1936 after a year with Gulf Pine Line.

▸ Bethlehem Supply Company has announced several promotions and changes in its field sales personnel.

F. J. Wilbanks, former field representative at Seminole, Oklahoma, has been promoted to the position of store manager and field representative at the Seminole store, replacing **H. R. Hoover,** who died recently. **E. L. Sharp,** formerly assistant store manager at Duncan, Oklahoma, has been transferred to Seminole as field representative to assist in the field sales in that area.

R. F. Wyers, formerly store manager and field representative at Lindsay, Oklahoma, has been transferred in the same capacity to the Duncan, Oklahoma, store. **F. D. Cox** has been transferred from Casper, Wyoming, to the Duncan store as assistant store manager.

J. C. LeFlore has been promoted from field representative to store manager and field representative of the Lindsay, Oklahoma, store. **Richard Evans, Jr.,** formerly in the Oklahoma City store, has been transferred to Lindsay and promoted to field representative to work the field in that area.

C. W. Young, formerly special representative at Garden City, Kansas, has been transferred to Russell, Kansas, and promoted to store manager and field representative of that store.

L. R. Cousland, formerly assistant store manager at Great Bend, Kansas, has been transferred to Garden City, Kansas, as special representative, replacing **C. W. Young.**

H. B. Karstetter, formerly field representative as Casper, Wyoming, has been promoted to the position of store manager and field representative of the Casper store.

T. C. McCord has recently been employed as a field representative in the used material department at Kilgore, Texas.

C. A. Patterson, formerly in the Odessa, Texas, store, has been transferred to Snyder, Texas, and promoted to field representative to assist in sales contacts in this active area.

▸ **Aubrey V. Baber** has been promoted to assistant general sales manager of the Owens-Illinois Glass Company, Kaylo division, and **T. F. (Tom) Sears** has been promoted to supervisor, Kaylo insulating roof tile sales. In his new position Baber will serve in a dual capacity of manager, insulation sales, and assistant general sales manager. A graduate of the University of Arkansas, Baber was formerly with Ludowici-Celadon.

Aubrey V. Baber

T. F. Sears

Sears joined Owens-Illinois in 1948, after working with Allis-Chalmers. He will have the responsibility of coordinating roof tile sales throughout the division as supervisor of Kaylo insulating roof tile sales.

▸ **Harold M. Winton** has been appointed director of training for the mechanical goods division, United States Rubber Company. Winton will supervise all training activities in the division's plants at Fort Wayne, Indiana, Passaic, New Jersey, Bristol, Rhode Island, Philadelphia, Pennsylvania, Sandy Hook, Connecticut, and in 27 sales branches in U. S. cities.

H. Merrill

▸ **Hamilton Merrill,** vice president and director of Manning, Maxwell and Moore, Inc., has been appointed Bridgeport and vice president in charge of the Consolidated-Ashcroft-Hancock division. This division operates plants in Stratford, Connecticut, Watertown, Massachusetts, Jersey City, New Jersey, and Tulsa, Oklahoma. Merrill is a graduate of Massachusetts Institute of Technology and has been with the company 30 years.

▸ **R. G. Ragsdale** has been named field sales and service representative for The Guiberson Corporation. He will be stationed in Houma, Louisiana. Ragsdale was formerly with Republic Supply Company in Louisiana and Wyoming.

▸ **Harold Atkins,** 48, secretary-treasurer of M. O. Johnston Oil Field Service Corporation, was stricken with a fatal heart attack at the company's office in Los Angeles, California and died March 31. His career with M. O. Johnston began 15 years ago when he became an accountant in the Johnston Houston office.

▸ **William G. Moser** has been appointed eastern sales manager and **Newell B. Case** has been appointed western sales manager of the meter division of A. O. Smith Corporation.

For the past two years, Moser has been Chicago, Illinois area sales manager. Before that he was assistant sales manager, New York division. He has been with the organization since 1936. Case has been Pacific Coast area sales manager since 1944. For 11 years prior to that time, he was associated with their Pacific Coast distributors.

▸ **E. W. Connolly** has been appointed sales manager of the Detroit, Illinois district of Haynes Stellite division, Union Carbide and Carbon Corporation. Connolly is a graduate mechanical engineer of the University of Detroit and has been associated with the Haynes Stellite division for 11 years as sales engineer in the Detroit district. He succeeds **R. D. Gunther,** who has retired.

▸ **Frank E. Tilley** was appointed manager of advertising and sales promotion of New York Belting and Packing Company, Passaic, New Jersey.

A native of Brooklyn, Tilley received his master of science degree from Columbia University. He joined the New York Belting and Packing Company, in March, 1939.

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE Petroleum Engineer
Irwin-Keasler Building
Dallas 1, Texas

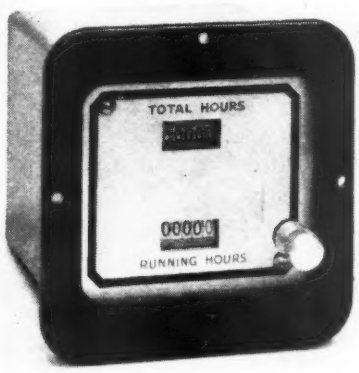
(1) Station Pump

Recently introduced on the market is the mechanically-sealed BJ Type TLB bulk station pump manufactured by Byron Jackson Company, Los Angeles, California. The new unit is for handling gasoline, butane, stove oil, diesel fuel, naphtha, kerosine, etc.

This pump has been specifically designed for bulk plant operation, utilizing the BJ mechanical seal. The unit is a single-stage, single-suction pump, close-coupled to an explosion-proof motor.

(2) Running Hours Meter

Phillips Petroleum Company, Bartlesville, Oklahoma, has developed a running hours meter. The accurate,



totally-enclosed, dust-proof, electrical recorder indicates total and current operating hours on separate counters. The meter, which consumes 4 watts of 115 volt, 60 cycle power, operates in any position. It requires 3½ by 3½-in. panel space, and weighs 18 oz. Each counter registers to 9999.9 hours in 6-min increments with knurled knob resetting running hours. The high torque, synchronous motor is lubricated for life. Electrical terminals are on meter back.

(3) Diesel Engine

Cummins Model LI-600 full diesel engines, equipped with gas-butane operating equipment has been developed by Cummins Sales & Service, Inc., of Fort Worth, Texas. The new engine is capable of delivering 280 hp maximum when burning 1000 Btu butane or 78 octane gas, the company claims. When operating on diesel fuel the ratio is 16:1. On natural gas-butane it is lowered to 6.8:1.

The engine has a 7-in. bore and 10-in. stroke. Crankshaft is 5½ in. diam and is mounted in copper lead bearings. Rollers are used on all upper and lower cam rocker levers. Weight of the engine is 10,400 lb.

(4) Rope Container

A new self-dispensing container for rope coils is now being used to package the New Bedford Cordage Company's pre-measured rope. Octagon in shape and clearly marked with size and fibre, this new corrugated container not only keeps the rope clean at all times but serves as a handy storage unit for the unused portion of the coil.

This storage feature is especially true for bulk buyers because the flat-topped container takes less room, stores easily, and can readily be stacked to the ceiling . . . a decided advantage over the ordinary covered rope coils.

Get Full Details of June, 1950, Listing—Check and Mail Coupon to

THE PETROLEUM ENGINEER

P. O. Box 1589, Dallas, Texas

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NAME..... TITLE.....

COMPANY NAME.....

STREET ADDRESS.....

CITY..... ZONE NO..... STATE.....

XUM

(5) Feed Control

Oil Well Supply Company, Dallas, Texas, has recently developed a new Brantly hydraulic feed control regulator. Through a combination of highly sensitive hydraulic and pneumatic systems, the regulator compensates immediately for changes in weight on the bit, adjusting the rate of feed-off of drilling line by means of a motor valve connected to the "Oilwell" Brantly feed control. The constant bit weight thus obtained, regardless of formation density, results in straighter hole, longer bit life, fewer round trips, and faster overall drilling time, according to the manufacturer.

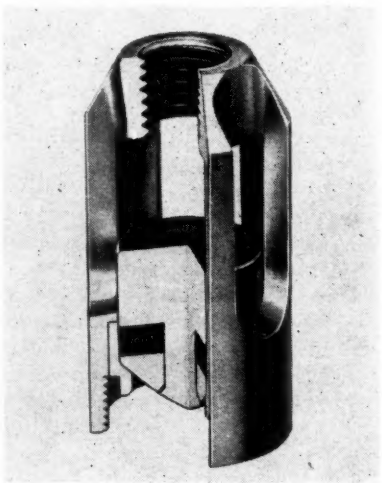
A dead line diaphragm is hydraulically connected through a pulsation dampner to a Fisher Wizard pilot. Impulses from the dead line are carried to the pilot through a closed hydraulic system and, through a pressure gage principle, actuate a flapper that controls the rate of escape of air from an orifice valve in the air system in the pilot. As the bit "drills off" and weight on the dead line increases, the increased pressure in the hydraulic system causes the flapper to move closer to the orifice, retarding the rate of air escape and thus increasing the pressure in the air system.

Air is supplied to the system from an outside source, and is filtered and regulated to a pressure of 25 psi.

Because the motor valve is opened by air pressur operating against a spring, failure of the air supply would cause the motor valve to close and the bit would only "drill off".

(6) Pump Valves

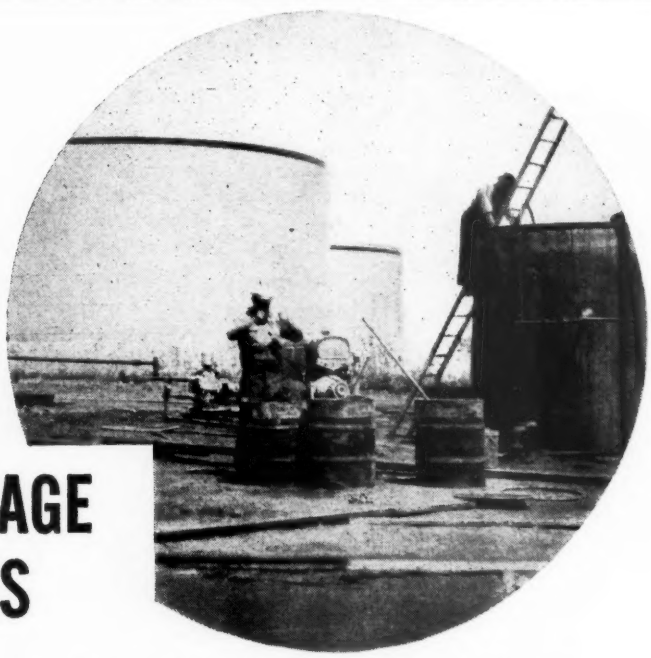
The Stewart Manufacturing Company of Stamford, Connecticut, announces its new twin-seat valve to replace the ball and seat in subsurface oilwell pumps. The twin-seat valve eliminates flutter and pump slippage, producing more fluid per stroke, the manufacturer claims. Its two seats



double the resistance to corrosive liquids and abrasive sands. The Stewart twin-seat valve seats steel-to-steel and is backed up with a rubber-to-steel seal-off. Experience has demonstrated that if the steel seat or valve is impaired by corrosive or abrasive fluids, the rubber-to-steel seal-off will perform effectively.

(7) Flame-Hardening

Linde Air Products, New York, N. Y., has developed a new method for flame-hardening tool joints. A tool shop working in the oil fields made this efficient setup for flame-hardening the face of tool joints. Equipment consists of a hollow spindle lathe, four heating heads manifolded to an oxy-acetylene heating blowpipe, and two compressed air quenching nozzles. A four-jaw chuck rotates the tool joints. The flames heat the face of the tool joint to about 1500 F, then blasts of compressed air quench the joint. Rockwell "C" hardness of the face is increased from 25 to 45 points. Depth of hardness is about $\frac{1}{8}$ in.—enough to help the face resist wear during the drilling operation. The entire hardening operation takes about a minute, the company states.

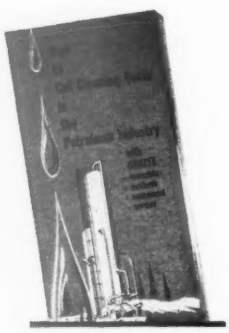


STORAGE TANKS

now cleaned and paint-stripped fast!

SPECIALIZED Oakite chemical cleaning materials, providing thorough cleaning and paint stripping action, make the difference between costly downtime and fast return to service for your storage tanks. Good point to keep in mind next time you have to clean tanks for product changeover . . . or repaint tank exteriors.

All you do is spray on a solution of recommended Oakite material . . . let it soak a short while to break oil or paint binders . . . then rinse off the loosened deposits. Inside is clean, ready to receive your product without contaminating it. Outside is clean down to bare metal, for repainting. Get all the facts about application and recovery methods FREE by calling your local Oakite Technical Service Representative, or by writing to Oakite Products, Inc., 44C Thames St., New York 6, N. Y.



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OAKITE

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PETROLEUM SERVICE DIVISION

(8) Gas Balance

The American Recording Chart Company, Los Angeles, California, has developed a new laboratory gas balance. This instrument is for permanent installation in a laboratory to determine specific gravity of gas samples brought in from field. Operating principle is identical to Arcco-Anubis dry air type gas gravitometer wherein the comparative weight of a column of dry air and equal column of gas determines the specific gravity. An air dryer is employed to remove moisture. Instrument also corrects for temperature and barometric pressure.

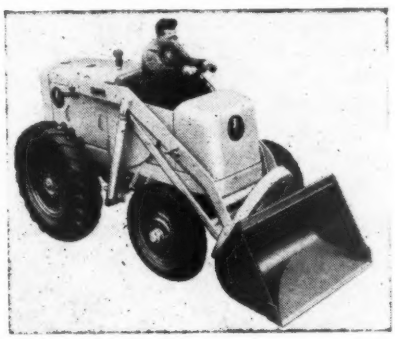
(9) Diesel Motors

The Murphy Diesel Company, Milwaukee 14, Wisconsin, has recently announced certain refinements in design that are claimed to provide more power, greater economy, greater dependability, and longer life. At the same time the number of models has been increased. Five 4-cylinder models and six 6-cylinder models ranging in output from 90 to 200 hp are now available.

The Murphy principles of "true" diesel operation, plain open combustion chamber, four valves per cylinder, hydraulic servo-type governor, etc., remain as the basis of design.

(10) Model HF Payloader

The Frank G. Hough Company announces its restyled Model HF ¾-yard Payloader tractor shovel. Four



forward speeds, from 2.4 to 19.5 mph, and four reverse speeds, from 3.5 to 28.7 mph, are provided in the full-reversing transmission. A new, heavy, cast radiator grille at the rear of the Payloader gives effective protection. Boom side-guards are also included as standard equipment.

(11) Glass Fiber Reinforcement

The Oklahoma Glass Fiber Corporation, makers of OK glass fiber reinforcement, announces the manufacture of a new fabric with cross-weave reinforcement for added strength in all directions. Longitudinal strength is as great or greater than before, with a great increase in transverse strength.

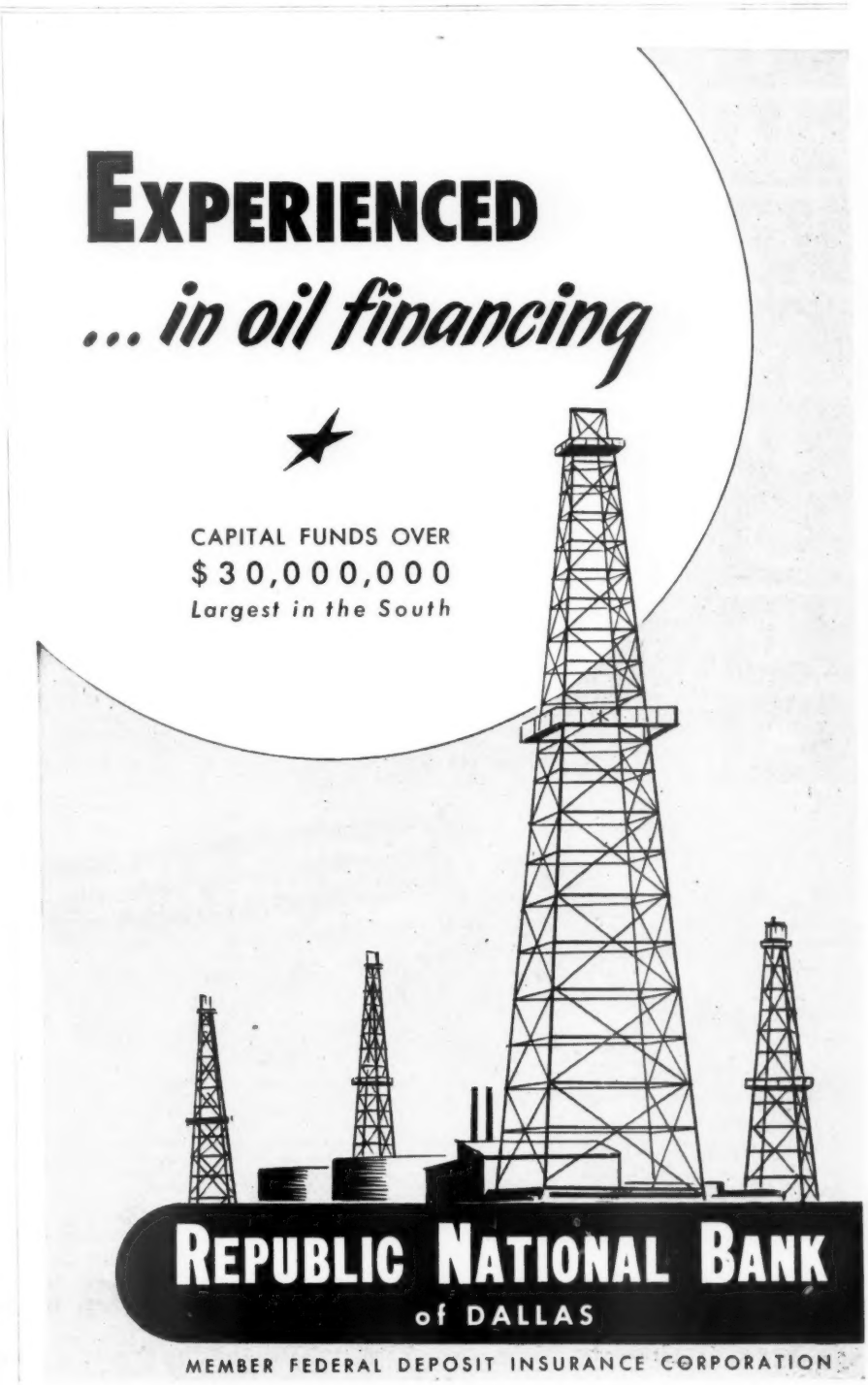
(12) Cooling Radiators

New design details for jacket water cooling radiators have just been incorporated into special Monoweld Radiators by Young Radiator Company, Racine, Wisconsin. Basically, the radiator is one of Young's line of Monoweld Radiators, however, by the use of special types of metals, the unit is practically corrosion resistant, states the manufacturer. All major ferrous parts are zinc plated, and the nuts, bolts, screws, and washers are cadmium plated.

The radiator is designed to maintain a maximum jacket water temperature of 180 F with a maximum of 120 F ambient air temperature. It will cool a 173-hp diesel engine running at 720 rpm driving a 100 kw generator, the manufacturer claims.

(13) Pipe Protectors

Development of a new line of all-purpose pipe protectors for the oil industry was announced recently by United States Rubber Company. The new pipe protectors are specifically designed to prevent casing and tool joint wear, lower vibration, friction, and torque during drilling operations, states the company.



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(14) Gas Lift Valve

A new gas lift valve time cycle surface control unit featuring a new all-contained motor valve has been announced by Camco, Inc., Houston, Texas. The new Camco motor valve consists of three parts and the valve assembly may be removed and replaced in a valve in operation and the motor valve put back in operation in less than five minutes.

The Camco motor valve is made of three parts: A diaphragm motor assembly, a valve case, and the valve itself. The diaphragm assembly is anchored to a cylindrical drip.

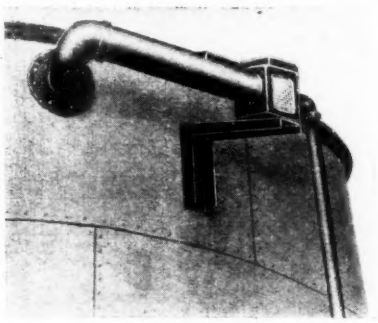
(15) Photomicrography

A photomicrographic apparatus, designed to serve all aspects of scientific photography, is announced by Silge and Kuhne, San Francisco, California. Named the Orthophot, it provides facilities for photomicrography; photomacrography; microprojection; laboratory, clinical, and general photography; photocopying; microfilming; x-ray photocopying; and photoenlarging.

The apparatus is used with any standard microscope, and comprises three basic units: 1. A base with permanently-aligned built-in light source operating on the Koehler principle with intensity-control maintaining constant color temperature, and with built-in color filters for black-and-white photomicrography. 2. A self-aligning reflex camera with precision focusing device (for use with No. 120 rollfilm, 2¼"x3¼" cut or pack film, and standard 35mm film), automatic Rapax shutter (1 sec to 1/200 sec, T & B); and 3. A vertical column assembly with counterbalanced elevating device for the camera.

(16) Fire Killer

American La France-Foamite Corporation of Elmira, New York, has developed a new fire killer called



Foamite Airfoam. This liquid is a stable, cohesive, free-flowing, protein-base foam fire extinguishing agent, composed of a specially treated protein of vegetable origin together with additives that control the viscosity, lower the freezing point, and control bacteria, the company claims.

Foamite Airfoam blankets fire with a thick, stable insulation that cuts off flame-supporting oxygen and smothers the blaze, and, the company claims, it floats on the surface of burning liquids and smothers fire, without harm to petroleum products or other flammable liquids.

(17) Horizontal Engine

The Lufkin Foundry and Machine Company of Lufkin, Texas, announces an addition to its line of oil field pumping equipment—the new Lufkin H-333 engine. Designed specifically for oil fields, the Lufkin H-333 horizontal engine is a two-cycle, two-cylinder, medium speed, crosshead construction engine. It has a speed range of 350 RPM to 750 RPM with a continuous horsepower rating of 20 hp at 425 RPM and 30 hp at 650 RPM. The bore is 5½ in. diam and the stroke is 7 in. Total displacement is 333 cu in.

Other features of this engine are full pressure lubrication, condenser cooling eliminating all water piping and water pumps, full metallic packing to seal the combustion gases from the crankcase, making the engine suitable for sour gas operation, and many others, the company claims.

T hree sizes for shallow, medium, and deepest wells

H and lever assures simple operation

O perates perfectly at maximum flow or idling

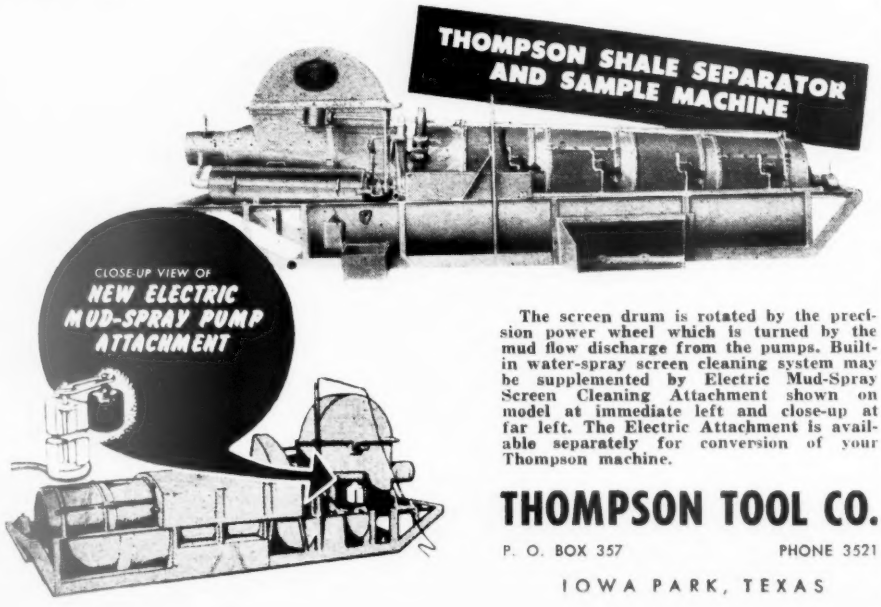
M ore profits - low cost to buy - no cost to operate

P rovides accurate foot by foot cuttings

S ample machine *Provides Accurate Samples*

O nly clean mud goes back into machines

N o abrasives to wear out equipment



The screen drum is rotated by the precision power wheel which is turned by the mud flow discharge from the pumps. Built-in water-spray screen cleaning system may be supplemented by Electric Mud-Spray Screen Cleaning Attachment shown on model at immediate left and close-up at far left. The Electric Attachment is available separately for conversion of your Thompson machine.

THOMPSON TOOL CO.

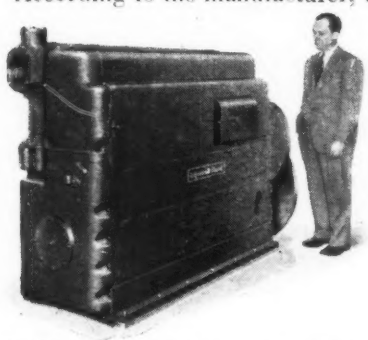
P. O. BOX 357 PHONE 3521

IOWA PARK, TEXAS

(18) Diesel Engine

A completely new type of diesel engine, in the 195-375 hp range, has been announced by the Ingersoll-Rand Company, New York 4, N. Y.

According to the manufacturer, the



TS diesel can easily be made portable, but is not automotive-type; it is small in size, but with big-engine design; light in weight, but with moderate speed; powerful, but with low exhaust temperature; perfectly balanced, but with no balancing devices. It is a four-cycle, 7-in. bore, 8½-in. stroke, single-acting engine with a weight of about 30 lb per horsepower, and a fuel consumption of 0.40 lb per horsepower-hour.

(19) Small Electric Motor

Raytheon Manufacturing Company, Motor Division, Russell Electric Company of Chicago, Illinois, has announced further developments in the construction of its Type 230 fractional horsepower motor. Manufacturing techniques have been worked out whereby a more uniform air gap is produced around the stator of this 1/200 to 1/50 hp motor. It is a small motor suitable for use in fans, blowers, heating equipment, and similar product applications and will be produced in both De Luxe and Economy models.

(20) Injector Valve

The Kinney Machine and Manufacturing Company has introduced a new plug injector valve and soluble plug. The Kinney plug injector method consists of two features—the Kinney valve, which is installed on the line near the well, and the Kinney Soluble Plug, which is injected into the valve at frequent intervals, as necessary.

The valve, or plug injector, is made in sizes from 1 to 3 in. for low pressure and high pressure, and larger sizes on special orders. While inserting plug into valve, the oil can still flow due to the 1-in. bypass built into the valve. By a turn of the handle, the flow is again directed through the valve and down the tubing, pushing the plug through the paraffin zone. The wax dislodged by the plug is then pumped out with the production oil.

(21) Pinch Valve

A new rubber pinch valve for use in the mining, paper, chemical, oil, food, and beverage industries, has been developed by the mechanical goods division of United States Rubber Company, New York, New York.

The new valve will outwear metal when installed in pipe lines carrying abrasive or corrosive mixtures, the company said. Its flexibility will offset misalignment in pipes. No packing or repacking is required. It absorbs vibration, eliminates "water hammer," and affords a positive seal in the closed position. Its metal parts can be refitted to new valve bodies thereby reducing replacement costs, and it will break up galvanic action in metal lines.

(22) AC-DC Coatings

Stoody Company, manufacturers of hard-facing alloys, Whittier, California, recently announced new ac-dc coatings for several of their electrodes formerly limited to dc application only. Among these are Stoodite, Tube Borium, and Borod. The ac-dc coated rods do not replace the older dc types, but are additions to the regular Stoody line.

With the development of ac-dc coatings, all Stoody alloys are now available for ac and dc application with the exception of Tube Stoodite.

Tube borium contains uniformly sized particles of borium (pure tungsten carbide) in mild steel tubes. Borod, similar in construction to tube borium but containing finer borium particles, duplicates the deposit and excellent wear-resistance characteristics of the standard dc-applied rod.

(23) Scaffolding

For oil refinery construction or maintenance work Tubelox scaffolding is a versatile and economical type, according to The Patent Scaffolding Company, Inc., Dallas, Texas.

Tubelox is available in light weight high carbon steel tubing or in aluminum. There are only four basic parts: Tubes, bases, and two types of couplers. The locking device between members makes continuous tubes. Diagonal connections, made with adjustable couplers, and right angle connections made with standard couplers, insure construction of strength and prevent sway and vibration. Coupler connections are made with a ratchet wrench.

(24) Pipe Wiper

A new design drill pipe wiper that features a single body to accommodate different sizes of inserts for various pipe sizes has been announced by Petroleum Mechanical Development Company, Houston, Texas. It will be marketed under trade name Flex-Lip.

Four features are claimed for the new pipe wiper by the manufacturer: (1) economy, as one body size accommodates all pipe and rotary sizes and it is necessary to replace only the inserts; (2) a floating accordion action that allows the wiper to follow the pipe on any off-center condition, so that it is always in contact with all parts of the pipe; (3) greater convenience in installation as the wiper can be installed or removed without pulling rotary bushings; and (4) a balanced design that gives the body strength, stiffness, and durability.

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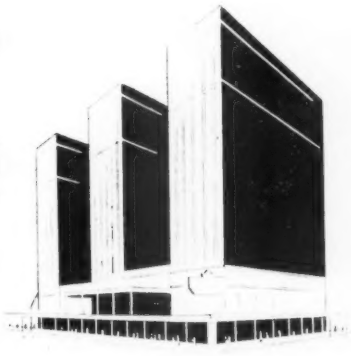

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THE RICE HOTEL

HOUSTON, TEXAS

B. F. ORR, *Manager*

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(25) Centrifugal Pumps

Worthington Pump and Machinery Corporation, Harrison, New Jersey, has recently published a 4-page bulletin on its 2-stage, double suction, centrifugal pumps.

Water-ways on the new centrifugal pump are carefully machined for smooth flow and high efficiency. Radial and axial balance are achieved through proper impeller and volute design, the manufacturer states. Other features are listed in the fully-illustrated bulletin.

(26) Drilling Handbook

A new 88-page, pocket-size handbook has been issued by Oil Base, Inc., 130 Oris Street, Compton, California. Charts, graphs, formulas, conversion factors, field tests, capacities of mud pits and tanks, sizes and capacities of casing and drill pipe, pump capacities, and relation between specific gravity, mud weights, and pressure head are some of the subjects covered in detail.

Instructions on mud procedures, raising and lowering of weight, increasing or decreasing viscosity and gel properties—how to combat mud contamination, use of oil emulsion muds, freeing stuck drill pipe, and hundreds of similar topics are also explained in this booklet.

(27) Regulating Valves

The Swartwout Company, 18511 Euclid Avenue, Cleveland 12, Ohio, announces a new 12-page bulletin covering the company's complete line of low pressure regulating valves for controlling gases and liquids in level, temperature or pressure requirements.

Bulletin S-22-C, printed in two colors and illustrated with photographs, diagrams and line drawings, gives full specifications and selection data on Swartwout regulating valves, valve accessories, etc.

(28) Plug Injector

Kinney Machinery and Manufacturing, Inc., has published a plug injector bulletin describing the Kinney method of removing paraffin from flow lines and the injection of the Kinney soluble plug into the Kinney valve. This method eliminates costly down time and keeps flow lines open at all times. The bulletin is fully illustrated.

(29) Refining Handbook

One of the best publications in the department of refining, is The Lummus Company's new 1950 handbook entitled *Petroleum Horizons*. This 80-page book covers petroleum refining, petroleum chemical, and chemical manufacturing activities. The main objective has been to build a manual that has high reference value, presenting pertinent material in an interesting, useful manner.

Thirty-one up-to-date flow diagrams of petroleum refining and petroleum chemical processes, including typical operating data, are reproduced in two colors—with color functionally used to facilitate tracing major streams from charge to products.

The balance of the book employs four colors to present 75 photographs of process units, as well as bar charts, drawings, and a flow diagram depicting processing sequence from crude oil to products in a modern refinery.

(30) Weld Pipe

A new 20-page booklet on pipe made by the electric resistance weld method has just been issued by Republic Steel Corporation, Cleveland, Ohio. Profusely illustrated, it contains a detailed description of the manufacturing process, outlined step by step. The center spread shows the sequence of operations in chart form.

One section is devoted to the structural and mechanical applications for the product, ranging from hot water heater flues to boom and dipper sticks for power shovels.

(31) Screen Cleaning

A schematic installation drawing and a typical wiring diagram are among the engineering details included in a new application engineering data sheet covering control of cleaning cycles for traveling screens, published by The Foxboro Company, Foxboro, Massachusetts.

The system depends upon the measurement of hydraulic loss across the trash rack and traveling screen. It initiates automatic cleaning for a regular cleaning cycle. If, for any reason, the cleaning fails to reduce the loss across the screen, emergency alarms are provided to warn operators of unusual operating conditions.

(32) Pipe Line Booklet

The Nordstrom Valve Division, Rockwell Manufacturing Company, Pittsburgh, Pennsylvania has published a booklet in which more than 100 photographs of pipe line installations are reproduced. Factual data pertaining to pipe line mileage are also included. Three double page multicolored maps, show the principal gas, crude oil, and products pipe lines, and will serve as an authentic reference.

Installations show latest arrangements of piping on main lines, in compressor and pumping plants, at tank farms, bridge crossings, town border stations, meter and regulator stations, way stations, and at terminals. In addition, details are given pertaining to valve controls on manifolds, main lines, pumps and compressors, etc. One section is devoted to the operation of automatic closing valves for emergency service with diagrams to show steps taken in automatic action.

(33) Warehouses, Offices

Worthington Pump and Machinery Corporation, Tulsa, Oklahoma has issued a flyer showing pictures of its four warehouses and offices in the Southwest, and listing its products. The four Worthington warehouses are in New Orleans, Louisiana, Tulsa, Oklahoma, Houston, and Fort Worth, Texas.

(34) Air Clutch

The Ideal Dy-A-Flex air clutch for use with Ideal Type 100 draw works is presented in a new 4-page illustrated bulletin issued by The National Supply Company, Toledo, Ohio.

Bulletin I-364 is illustrated to show the design, component parts, and operation of National's most recent clutch development. A feature of the bulletin is an engineering drawing that shows how any Ideal Type 100 draw works, regardless of clutch now employed, can be converted to utilize the Dy-A-Flex Clutch.

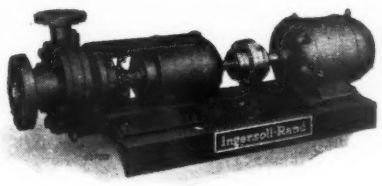
(35) Refractory Concrete

A revised 24-page edition of the booklet "Lumnite Refractory Concrete" has just been published by Universal Atlas Cement Company, Lumnite Division, New York, New York. Latest information on refractory and heat-resistant concrete is given in this new edition of the booklet.

Detailed information on refractory concrete mixes—proportions of Lumnite and various aggregates—is given in this booklet. From the tables contained in this publication, a selection of the proper types of refractory concrete for a wide range of temperatures and insulating conditions can be made.

(36) Centrifugal Pumps

Ingersoll-Rand Company, Phillipsburg, New Jersey, announces the publication of a new piece of literature introducing a new line of cradle-mounted centrifugal pumps, known as the CRVR, for process and refinery service. This four-page booklet contains a sectional view of the pump with all of its important features pointed out and described. Dimensions and specifications are also included.



(37) Bearing Engineer

The Bearing Engineer, March-April issue, has recently been published by The Torrington Company, 295 Madison Avenue, New York, New York. This issue contains a description of the Cameron slitting and roll-winding machines, manufactured by the Cameron Machine Company, Brooklyn, New York; hitch and die feeds manufactured by H. E. Dickerman Manufacturing Company, Springfield, Massachusetts, and other Torrington equipped items. It also includes a question and answer section answering questions of a general nature.

(38) Pumping Service

How to select large motors for pumping service in the oil industry is the feature article in the oil industry number of the E-M Synchronizer, published by Electric Machinery Manufacturing Company, Minneapolis, Minnesota. Other articles include insulation requirements, safety of motor controls, electric power generation for oil field use, electric power generation in field processing plants and in compressor stations.

Also this two color, 24-page issue describes the recently installed Basin Ozark pipe line.

(39) Floating Roofs

Chicago Bridge and Iron Company, 332 South Michigan, Chicago 4, Illinois, announces the publication of a new 20-page booklet, "Horton Floating Roofs", which contains information on the reduction of evaporation loss and corrosion and the elimination of fire hazards in flat-bottom tanks storing volatile liquids and chemicals.

The three types of Horton floating roofs—Double-Deck, Pontoon, and Pan—are described and the service for which each roof is used, is discussed.

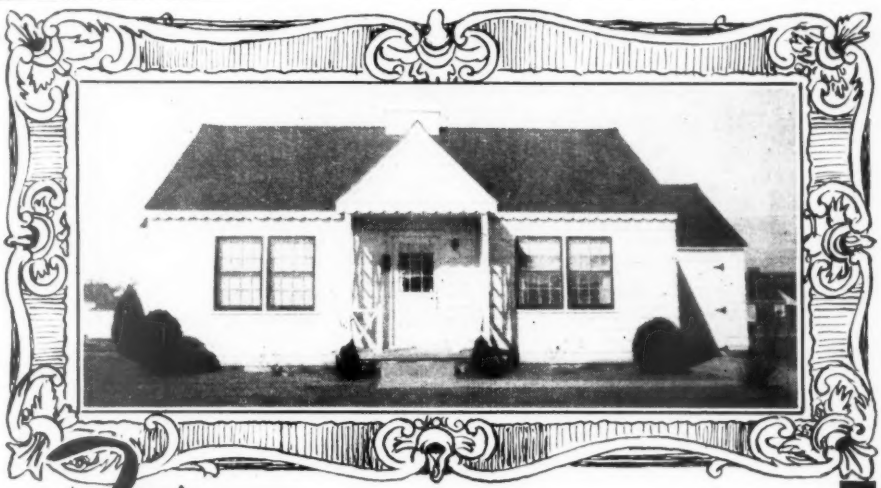
(40) Boiler Tubes

A new bulletin of technical data on electric-resistance-welded steel boiler tubes has been announced by The Babcock and Wilcox Tube Company, 85 Liberty Street, New York, N. Y. For convenience in ordering, tables are furnished on maximum allowable working pressures, conforming to ASME Specification SA-178, for different diameters and gages of tubes for water-tube and fire-tube boilers. Another table determines the weight in pounds per lineal foot of steel tubes in various minimum wall sizes.

(41) Bits and Junk Catchers

How to get junk out of the hole is completely illustrated and described in the new Globe junk catcher folder, recently published by Globe Oil Tools Company, Los Nietos, California. The Globe patented junk catcher is an all-around emergency tool with three features. It drills; reams side wall to gage; and recovers junk.

Globe has also published a 4-page folder illustrating its complete line of patented rock bits. These bits are especially designed for today's deeper, high-speed operation, it is said.



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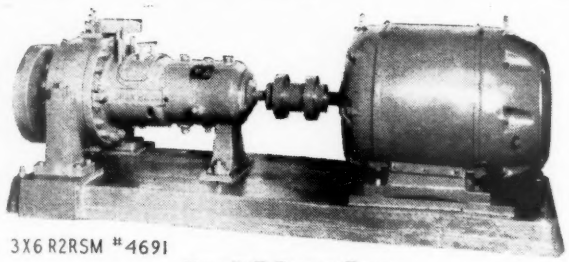
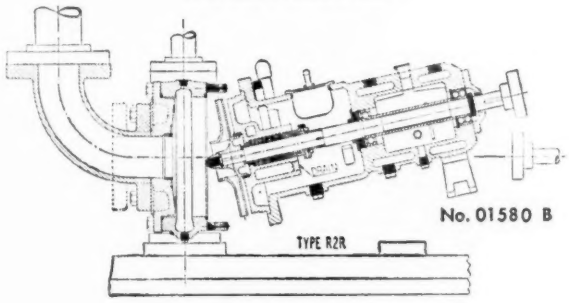
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

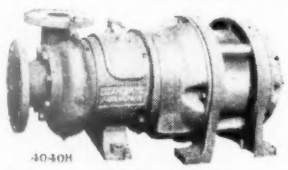
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

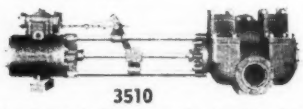
Capacities: 50 to 2000 Gallons per minute. **Heads:** Up to 400'. **Speeds:** 900 RPM to 1000 RPM.

BUILDERS OF OUTSTANDING PUMPS
SINCE 1869

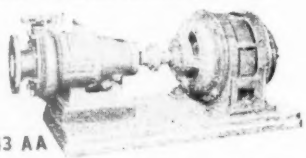
CENTRIFUGAL and RECIPROCATING PUMPS



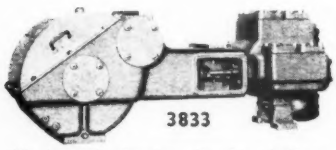
Close Coupled Centrifugal Pump



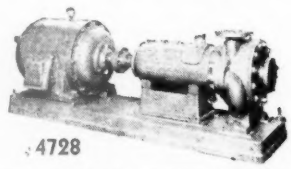
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



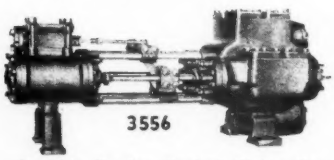
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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Representatives in Principal Cities

(42) Oil Seals

Johns-Manville, New York, New York, has published a 16-page handbook of data on oil seals. Photographs show where to use Clipper Seals and how to install them. Drawings illustrate how the lip and heel construction of these non-metallic oil seals can be varied.

The text gives other pertinent information of importance to designers, engineers, and maintenance men. The booklet is divided into sections on the principle of Clipper Seals, their construction, advantages in various applications, and installation data.

(43) Pumping Equipment

Westinghouse Electric Company has published a 47-page booklet listing the many products employed in oil production refining, transportation, and marketing. The book, which contains many photographs, charts, and drawings, is devoted to oil field electrification as it applies to oil well pumping. It covers every phase of electrification from motor to power supply. It emphasizes the value of electrification for improving pumping operations and provides information to assist in electrifying any oil lease.

The text is a handy manual that shows how pumping operations may be improved through electrification.

(44) Water Clarifiers

A new 12-page bulletin on water clarifiers and cold process softeners is now available from Graver Water Conditioning Company, Department 135, 216 West 14th Street, New York 11, New York.

The bulletin graphically describes the design, operation, and features of the Graver unit of this type, known as the Reactivator, with explanations in tabular form for greatest clarity. Introductory sections of the bulletin concisely explain the principles and chemistry of cold process water treatment, and compare the Graver reactivator with other methods of water purification.

(45) Shipping Estimator

The air express division of the Railway Express Agency, New York, New York, has available air rate shipping estimators. The circular estimators give the air express rates for anything from one pound to over 50 lb. which is shipped from 149 to over 2350 miles. Made in two parts, the top disc is twirled opposite the weight of shipment, shown in outer disc. The approximate shipping distance is given in the opening slot of the top disc, and opposite the mileage, is the approximate cost of air expressing.

(46) Coated Fabrics

Vulcan Proofing Company, New York, New York, has issued a six-page catalog listing the company's line of coated fabrics for industrial use. One section is devoted to cotton base fabrics, developed to meet the special and exacting requirements of the gas industry for use in meters, regulators, valves, and controls.

Other sections are concerned with Vulcan natural rubber coatings: coated fabrics for automotive use; special purpose fabrics; hycar, neoprene, and natural rubber sheet stock; uncured coated fabrics, and uncoated sheet stock.

(47) Tapered Caisson

Ben C. Gerwick, Inc. & Stolte, Inc., San Francisco 11, California has published a 28-page brochure describing the company's step-tapered caisson type of marine platform for off-shore drilling and other purposes. The front and back pages are of transparent plastic, and the booklet is fully illustrated with pictures showing underwater derricks.

A feature of the tapered caisson is that it provides a broad stable base at the bottom with a minimum section and obstruction at the water surface where the wave pressures are the heaviest. It also permits economical platform construction and drilling in much deeper water, up to 200 ft and more, as compared with 50 or 60 ft, the limit for the more conventional pile construction.

(48) Recording Thermometers

Publication of a 6-page bulletin on pipe line recording thermometers for natural and manufactured gas temperatures has just been announced by The Bristol Company, Waterbury 20, Connecticut. In addition to a complete description of the "Series 500" pipe line recording thermometer, considerable information is given on the specially-designed bulb. The bulletin, No. T843, is illustrated with photographs and drawings.

(49) Gear Reducer

De Laval Steam Turbine Company, Trenton 2, New Jersey has published a new bulletin featuring its herringbone gear reducers. This new bulletin covers a new line of heavy duty herringbone gear reducers for capacities up to 1000 hp. It contains complete descriptions of single, double, and triple reduction units, complete horsepower rating tables for standard and semi-high speed units, over-hung load rating tables, dimensions, and weights. A section is devoted to the method of selecting herringbone gear reducers.

(50) Industrial Lubrication

"Eleven ways to cut production costs" are graphically portrayed in a pocket-sized primer on industrial lubrication published by the Alemite division of Stewart-Warner Corporation, 1826 Diversey Parkway, Chicago 14, Illinois.

In its foreword the booklet declares that lubrication "protects management's largest investment of capital" and that it affects the quality, quantity, and cost of all goods produced. Eleven examples of production or machinery expense economies, attained through modern handling and application of greases and oils, are presented in the booklet, with advantages over methods they are designed to improve given in terms of lubricant savings, increased production use of machinery, and elimination of labor costs.

(51) Price Catalog

A new 12-page descriptive price catalog on Red Devil liner pullers for slush pumps has been issued by Oil Well Manufacturing Corporation, 6000 South Alameda Street, Los Angeles, California. Red Devil liner pullers are made in two types—the "Universal Type" for conventional slush pumps and the "Expanding Grip Type" for thin wall liners.

(52) Price Sheets

The Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania has issued master price sheets for pressure tubing. These master price sheets, identified as price schedule "A", give the base prices per 100 ft of average and minimum wall hot finished and cold drawn seamless carbon steel pressure tubing.

The schedule covers cut length tubing produced from open hearth steel having an average carbon content within .10 to .25 per cent and having outside diameters ½ through 10¾ in. and wall thicknesses .035 through 1.000 in.

(53) Generators, Furnaces

Petro-Chem Development Company, Inc., of New York City have issued two 4-page technical bulletins—50-1 and 50-2, which describe and illustrate its Iso-Flow steam generators and its Iso-Flow furnaces. Bulletin 50-2 contains a detailed summary of the design and operating characteristics and operating test data on a 30,000 lb per hr Iso-Flow steam generator installation.

Bulletin 50-1 describes and illustrates the Petro-Chem Iso-Flow furnace, radiant convection design, and includes the design and operating characteristics of these furnaces.

FOR YOUR 7 TO 13 H.P. POWER JOBS

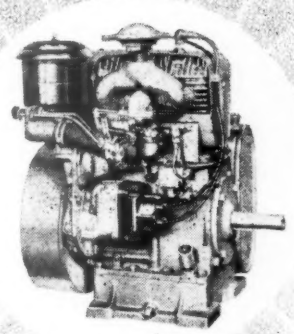
Two-Cylinder

WISCONSIN

Heavy-Duty

Air-Cooled

ENGINES



Models TE and TF standard engine illustrated; also available as complete Power Units with Clutch Take-Off Assembly or with Clutch Reduction Assembly.

Designed and built to traditional Wisconsin Motor heavy-duty service standards, this pair of Air-Cooled 2-cylinder engines provide ideal power either as component units on original equipment, or as stationary or portable general-purpose power within the 7 to 13 hp. bracket.

The Model TE delivers from 7.2 to 11.2 hp. and the Model TF turns up 8.6 to 13.3 hp. within a 1400 R.P.M. to 2600 R.P.M. speed range. Features include: tapered roller bearings at BOTH ends of the heat-treated, drop-forged crankshaft; high tension rotary-type OUTSIDE Magneto with impulse coupling; oil bath air cleaner; ¾" standard float feed carburetor; positive lubrication by Pump with individual oil stream to each rod . . . *plus* dependable air-cooling at all temperatures from sub-zero to 140° F.

For "Most H.P. Hours" of on-the-job power service, specify Wisconsin Air-Cooled Engines . . . single cylinder, 2-cylinder and 4-cylinder, in a complete power range from 3 to 30 hp.

WISCONSIN MOTOR Corporation

MILWAUKEE 14, WISCONSIN

World's Largest Builders of Heavy-Duty Air-Cooled Engines

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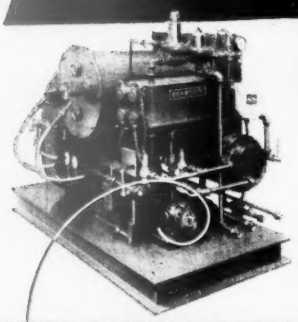
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

ROPER SERIES F PUMP



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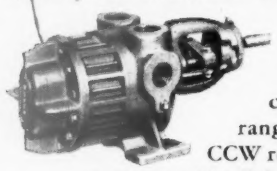
PEABODY
AUTOMATIC BURNER

Heavy fuels used in industrial burners must be supplied at the *exact pressure* and exact viscosity to get maximum burner efficiency. That is one reason why Peabody depends on Roper Rotary Pumps.

QUIET, DEPENDABLE OPERATION...4-PORT DESIGN



Smooth-operating; dependable pump with 4-port design that saves installation time and costs. Eight optional piping arrangements — 4 for CW and 4 for CCW rotation. Sizes 1–300 G.P.M., pressure up to 300 P.S.I. Parts and construction features assure long service life.

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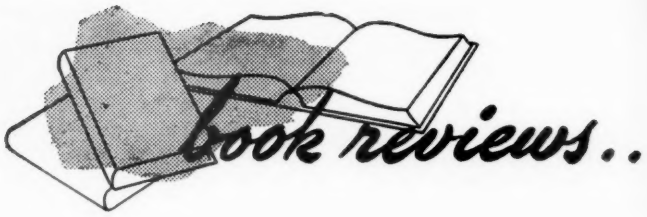

Rinehart's Silver Anniversary Yearbook, 1950, *compilation of Rinehart Oil News Company, P.O. Box 1208, Dallas, Texas. Price, $10, subscribers—$15 non-subscribers.*

This, the eleventh annual edition, contains a resumé of the oil industry in 1949. It includes a financial section, dealing with tax proposals and transactions in the petroleum industry in 1949, as well as a listing of the discoveries made in the U. S., with each state indexed individually. Volume 1 devotes a section to U. S. oil production, yearly and cumulative yearly record of wells drilled in the U. S. and a map showing the petroliferous provinces of the U. S. It also contains a listing of the discoveries made in the Mid-Continent region and in Texas in 1949. Volume 2 deals with discoveries in the Rocky Mountain States and the southeastern states.

Standard Methods for Testing Petroleum and Its Products, *10th edition, 1949. Published by the Institute of Petroleum, 26 Portland Place, London, W.1. Pages, 660. Price 31s.6d, post free.*

Containing 660 pages of data describing the apparatus for and the procedure of 116 methods for determining physical and chemical properties of crude petroleum and its products, this edition has undergone numerous changes since the 1948 edition.

Three new methods of considerable importance are: (1) An engine method of testing heavy-duty lubricants in relation to ring-sticking, wear, and deposit accumulation; (2) a method for research octane number of motor fuels: (3) and a method of assessing the corrosive tendencies of cutting oils in contact with cast iron. Various methods have been revised in detail.

Appalachian Geological Society, *Vol. I., Charleston Printing Company, Charleston, West Virginia, P.O. Box 2605. Pages, 552. Price, $6.75.*

This bulletin contains 47 different papers by distinguished authors on geological problems and practical problems confronting the oil and gas operators daily. Also included in the book are pictures of the 1948-49 officers, and a listing of the 1950 officers, as well as members of the different committeemen of the Appalachian Geological Society.

Data Book on Hydrocarbons, *by J. B. Maxwell, D. Van Nostrand Company, Inc., New York. Pages, 259. Price, $5.*

The outgrowth of years of work on the part of Standard Oil Development Company's engineers to assemble and test data on hydrocarbon properties and to apply these data to process engineering, this book represents the major items of data required for these purposes by the refining engineer. It has been used by S. O. D. and other affiliates of Standard Oil (New Jersey) for an extended period and has proved to be quite valuable to technical personnel, says the author. The work includes some fundamental theory, some illustrative examples, and shows a few applications of the theories and the data to those unit operations of chemical engineering that have been applied extensively in the petroleum refining industry.

Much tabular data are presented, including tables on boiling points, characterization factor and other primary properties, fugacities, vapor pressure, thermal properties, viscosity, flow of fluids and of heat, and fractionating towers.

THE Petroleum Engineer

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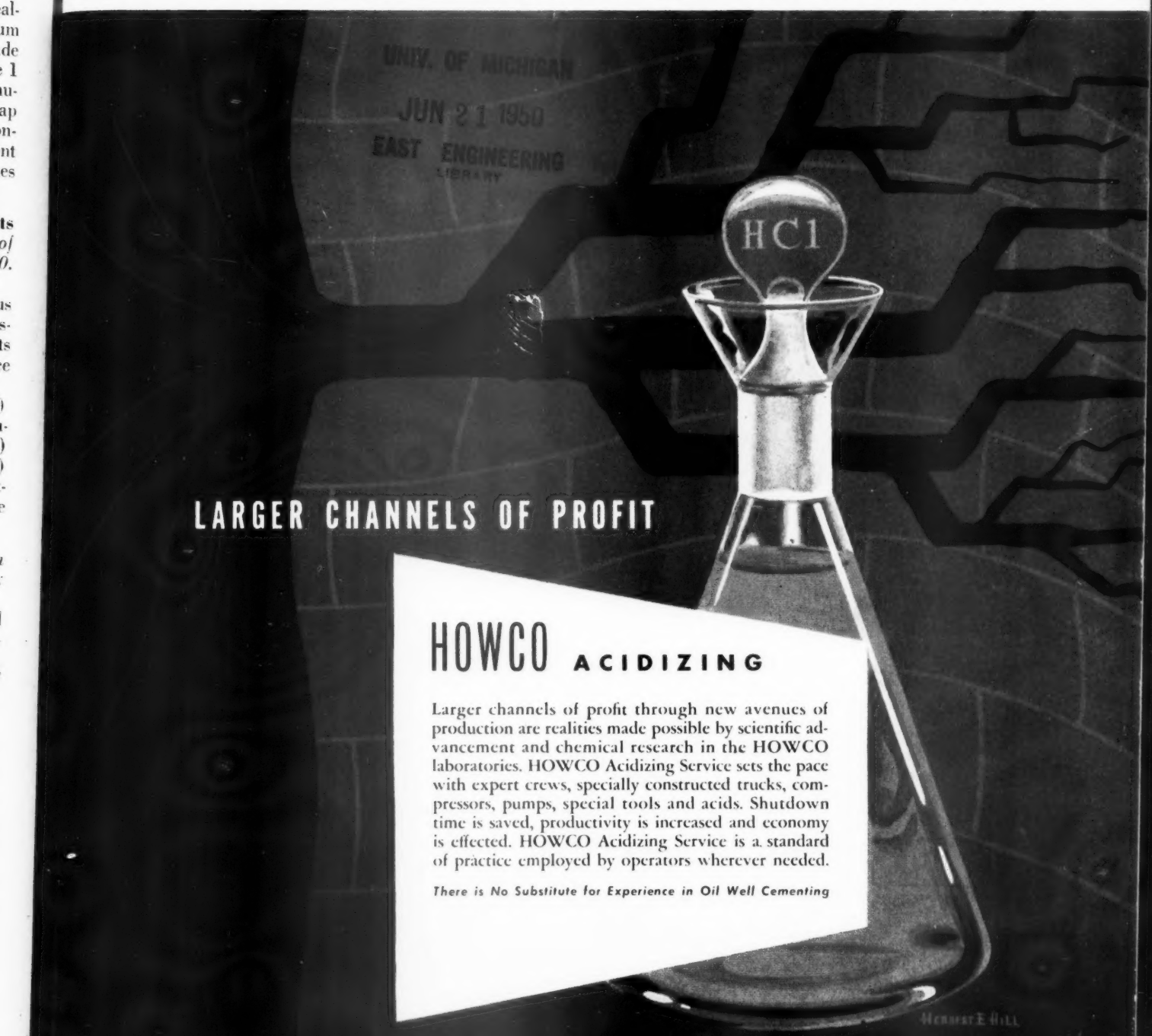
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